TEACHERS' MANUAL AND KEY TO ACCOMPANY THE NEW BASIC SCIENCE

J. DARRELL BARNARD

Chairman, Department of Science Education, School of Education, New York University

LON EDWARDS

Chairman, Science Department, Danbury (Conn.) State Teachers College

RRICULUM

Q
161
B25
1956
tch.man.

MILLAN COMPANY
RK

CURR HIST

Ex libris
universitatis
albertaensis

Digitized by the Internet Archive
in 2017 with funding from
University of Alberta Libraries

https://archive.org/details/newbasicsciencetbarn

Educ
Q
161
B25
1956
Manual

BARNARD, JOHN DARRELL

ONTENTS

ntroduction ii
ow Does *The New Basic Science* Relate to a Dynamic Science Program? 1
ow Can You Most Effectively Use *The New Basic Science*? 16
ilms 40
aterials and Sources 47
ey to Tests and Chapter- and Unit-End Activities 52

INTRODUCTION

From our experience with science teachers in various parts of the country and from our acquaintance with the research in science teaching, we have been impressed with a recurring pattern. Science teachers in general agree upon the major objectives for science teaching. Furthermore, they desire to improve their teaching so that they can better achieve those objectives. Although many of them are earnestly seeking ways of improving their teaching, they need help. With these things in mind, we have written *The New Basic Science*. In the textbook and this manual we share, from our experience as science teachers, some of the more effective ways of obtaining and sustaining pupils' interest in science, of directing learning experiences toward the accepted objectives of science teaching, and of evaluating achievement.

UNIVERSITY
OF ALBERTA LIBRARY

HOW DOES *THE NEW BASIC SCIENCE* RELATE TO A DYNAMIC SCIENCE PROGRAM?

Science in the Schools

By the time that you get to the point of reading this manual you have already accepted science as something that should be taught in the schools. You have science courses in your school and *The New Basic Science* has been selected as the textbook for your course. Even though all of this has been settled—it might be a good idea to re-examine briefly a question which you probably have thought about many times: Why teach science?

In our schools we have two points of reference in considering questions regarding what and how we should teach. One of these is the society in which we live. The other is the individual. We have to examine both of them, and their relation to each other, to get a clear picture of each. Because the interaction of these two produces a complex phenomenon, the answers to the questions may not be easy to find. But to find them is our task as *professional* educators. This is our work as *professional* science teachers.

Professional educators for a long time have been focusing their best thinking upon such questions as: What is the nature of our society? How do young people grow and develop in such a society? What should be the function of education in fostering their growth and development?

Our American democracy is characterized by a basic belief in and respect for the individual. It is founded upon the belief that each one of us is a distinctly different individual. Each has the right and obligation to develop his unique capacities in socially accepted directions that are satisfying to him. We therefore believe that in our democracy the people, you, me and all the rest, should participate in making the decisions that in turn are going to affect us. These represent some of the basic tenets of democracy that have great importance for you and me—teachers of science.

What are some of the questions citizens in a democracy must try to answer? Should the discoveries of scientists be kept secret? Should the government spend more money for basic research in science? Should we fluorinate our community water supply? Each of us will be affected by the ways in which these and other such questions are answered. Science and technology, having introduced such problems, must help toward an understanding and solution of them.

Education is responsible for guiding the development of young people so that they will be competent to participate effectively in such responsibilities, and will have the knowledge and skill to insure the most intelligent decisions at the time.

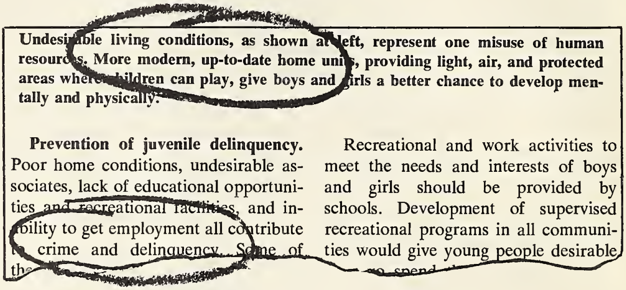
If science programs in the schools are organized and taught with a real belief in this point of view, they can contribute to its achievement in many ways. The

215815

authors of *The New Basic Science*, who strongly believe this, have organized the science content of the book, and the variety of pupil activities in it, so that young people can develop the competence required for effective citizenship in a democracy.

The Science Learner

The individual, of course, is the most basic part of the picture, because he is the one who shapes the society. He is also the most complex variable in the educational process. No two of us are alike. Nor is any one of us the same at all times. In spite of this great variability, we do have some rather basic needs, common to all. Each of us seeks security and satisfaction in the things we do. We want to be

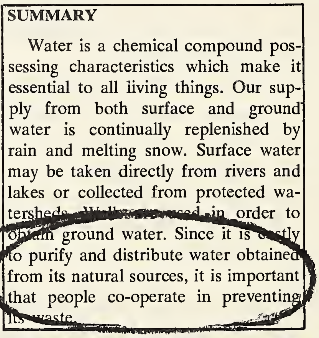


Undesirable living conditions, as shown at left, represent one misuse of human resources. More modern, up-to-date home units, providing light, air, and protected areas where children can play, give boys and girls a better chance to develop mentally and physically.

Prevention of juvenile delinquency. Poor home conditions, undesirable associates, lack of educational opportunities and recreational facilities, and inability to get employment all contribute to crime and delinquency. Some of th

Recreational and work activities to meet the needs and interests of boys and girls should be provided by schools. Development of supervised recreational programs in all communities would give young people desirable

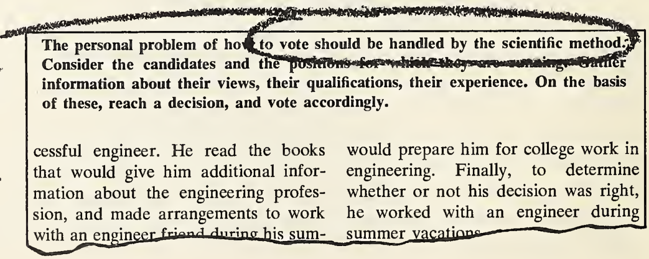
Community problems that should concern all citizens (p 467)



SUMMARY

Water is a chemical compound possessing characteristics which make it essential to all living things. Our supply from both surface and ground water is continually replenished by rain and melting snow. Surface water may be taken directly from rivers and lakes or collected from protected watersheds. Wells are used in order to obtain ground water. Since it is costly to purify and distribute water obtained from its natural sources, it is important that people co-operate in preventing its waste.

another question affecting all citizens. (p. 58)

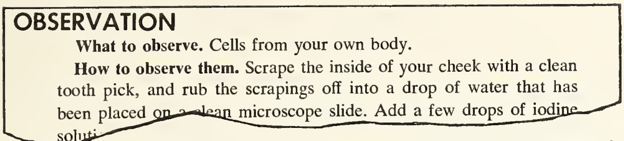


The personal problem of how to vote should be handled by the scientific method. Consider the candidates and the positions for which they are running. Gather information about their views, their qualifications, their experience. On the basis of these, reach a decision, and vote accordingly.

cessful engineer. He read the books that would give him additional information about the engineering profession, and made arrangements to work with an engineer friend during his sum-

would prepare him for college work in engineering. Finally, to determine whether or not his decision was right, he worked with an engineer during summer vacations

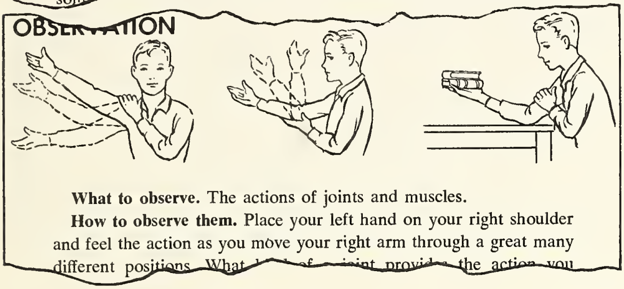
Science and the important business of good citizenship (p. 19)



OBSERVATION

What to observe. Cells from your own body.

How to observe them. Scrape the inside of your cheek with a clean tooth pick, and rub the scrapings off into a drop of water that has been placed on a clean microscope slide. Add a few drops of iodine solu

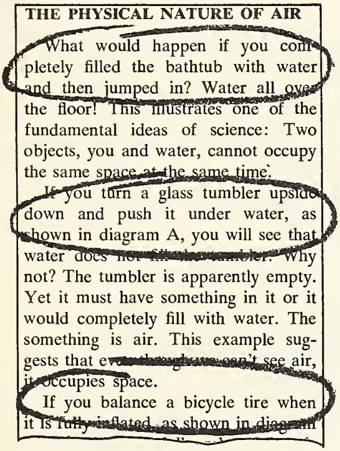


OBSERVATION

What to observe. The actions of joints and muscles.

How to observe them. Place your left hand on your right shoulder and feel the action as you move your right arm through a great many different positions. What kind of joint provides the action you

Activities that relate to a primary interest of young people themselves! (p. 321)



THE PHYSICAL NATURE OF AIR

What would happen if you completely filled the bathtub with water and then jumped in? Water all over the floor! This illustrates one of the fundamental ideas of science: Two objects, you and water, cannot occupy the same space at the same time.

If you turn a glass tumbler upside down and push it under water, as shown in diagram A, you will see that water does not fill the tumbler. Why not? The tumbler is apparently empty. Yet it must have something in it or it would completely fill with water. The something is air. This example suggests that even though we can't see air, it occupies space.

If you balance a bicycle tire when it is fully inflated, as shown in diagram

Little in terms of science background is taken for granted Concepts are developed from experiences of young people. (p. 28)

a part of the group and participate in its work. We want to believe in ourselves and in many ways be self sufficient. Although at times it may not be evident, there is a desire to be creative—to express the "new" idea, to make the unique contribution. We need some frame of reference or values out of which we can achieve self direction. We want to realize a sense of achievement in our learning efforts. If an educational enterprise, such as a course in general science, is to be effective, it must take into consideration these basic needs and interests of young people. Specific provisions must be made for meeting them. It cannot be assumed that each pupil will somehow work these out for himself, unassisted. Nor can it be assumed that all young people at any one grade level express these needs to the same extent. Nor do they have the same capacity and readiness to learn.

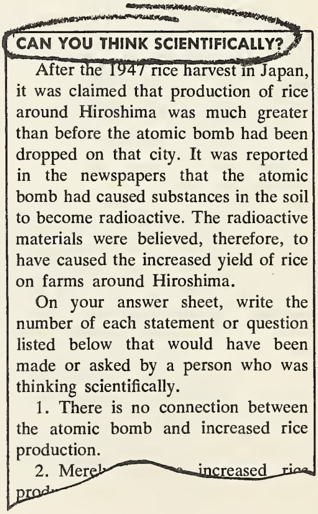
There is great variability in their backgrounds of experience and the manner in which they have been affected by those experiences.

The New Basic Science is a learning guide in science. It assumes no one standard level of background in science. Even though all pupils in the course in any one school may have had two or more years of work in science, there will still be wide differences in the extent to which they have achieved science learnings. Nor do the authors of *The New Basic Science* assume that all pupils who use the book will learn the same amount of material. Therefore, recognizing such differences, we have used as the point of departure the things which are most common in the present experiences of young people. From such starting points science concepts are developed in the book. The many aids to learning which it includes were planned with full recognition that some pupils are going to need more help than others. The great variety of activities in it have been selected and planned to provide for the individual differences which we all know will exist in classes using *The New Basic Science.*

The Science Teacher

Because *The New Basic Science* has been prepared with primary attention to the learner, it has also given basic consideration to the teacher. Just as young people who come into your science class are different, you teachers who will be using *The New Basic Science* are different. For some of you this may be your first year of teaching science. Others may have been teaching it for years. Some of you may have little background in formal science courses. You may be in a position of having to learn a lot of science along with your pupils. Others may have strong majors in science. Some of you may see very little in science to become excited about and are taking over the job as an assigned teaching

Clues for the teacher in frequent activities calling for critical thinking about current happenings (p.401)



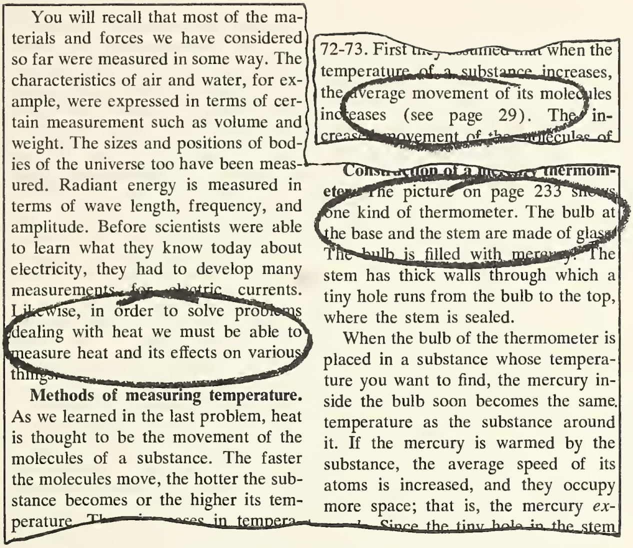
CAN YOU THINK SCIENTIFICALLY?

After the 1947 rice harvest in Japan, it was claimed that production of rice around Hiroshima was much greater than before the atomic bomb had been dropped on that city. It was reported in the newspapers that the atomic bomb had caused substances in the soil to become radioactive. The radioactive materials were believed, therefore, to have caused the increased yield of rice on farms around Hiroshima.

On your answer sheet, write the number of each statement or question listed below that would have been made or asked by a person who was thinking scientifically.

1. There is no connection between the atomic bomb and increased rice production.

2. Mere increased



You will recall that most of the materials and forces we have considered so far were measured in some way. The characteristics of air and water, for example, were expressed in terms of certain measurement such as volume and weight. The sizes and positions of bodies of the universe too have been measured. Radiant energy is measured in terms of wave length, frequency, and amplitude. Before scientists were able to learn what they know today about electricity, they had to develop many measurements for electric currents. Likewise, in order to solve problems dealing with heat we must be able to measure heat and its effects on various things.

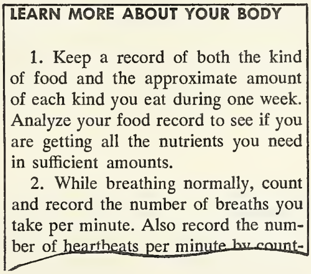
Methods of measuring temperature. As we learned in the last problem, heat is thought to be the movement of the molecules of a substance. The faster the molecules move, the hotter the substance becomes or the higher its temperature. The increases in tempera-

72-73. First they assumed that when the temperature of a substance increases, the average movement of its molecules increases (see page 29). The increase in movement of the molecules of

Construction of a mercury thermometer. The picture on page 233 shows one kind of thermometer. The bulb at the base and the stem are made of glass. The bulb is filled with mercury. The stem has thick walls through which a tiny hole runs from the bulb to the top, where the stem is sealed.

When the bulb of the thermometer is placed in a substance whose temperature you want to find, the mercury inside the bulb soon becomes the same temperature as the substance around it. If the mercury is warmed by the substance, the average speed of its atoms is increased, and they occupy more space; that is, the mercury *expands*. Since the tiny hole in the stem

Many kinds of help — relating measurements to science; cross references; relating pictures to text (p. 231)



LEARN MORE ABOUT YOUR BODY

1. Keep a record of both the kind of food and the approximate amount of each kind you eat during one week. Analyze your food record to see if you are getting all the nutrients you need in sufficient amounts.
2. While breathing normally, count and record the number of breaths you take per minute. Also record the number of heartbeats per minute by count-

Showing how science makes a difference in everyday life (p. 357)

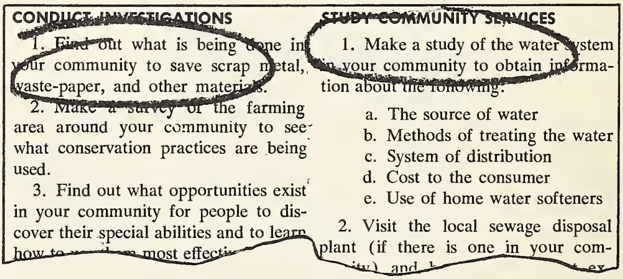
"chore." Others of you may be so excited about it that you have been accused of not knowing that there is anything else to life. For teachers with a limited background, *The New Basic Science* along with the workbook can serve as a guide in which your "science" may be learned or reviewed in relationship to the problems for which it is basic. For you who may be unexcited about science, the enriched activities in the text will help you understand why people who get involved in such science activities do become excited about science. Just as in swimming, golfing, or other such activities, one becomes more excited about them when he becomes involved in the process. You should remember, however, that as in swimming or playing golf, your first efforts may not represent a finished performance. For the teacher who has a good background in science and believes that science should make a difference in the lives of young people, *The New Basic Science* will help you to organize materials and activities toward the realization of such a goal.

Science and the Community

Although the learner and the teacher are basic considerations in the development of a good science program, the community also has an important role. The community is not only a laboratory which can be used from time to time to illustrate concepts of science, but it is also a laboratory in which real problems, problems that make a difference in community life, can be explored and worked upon by young people. As is true with the learner and the teacher, communities also vary. No two of them are identical. Some of the schools using *The New Basic Science* are in rural communities, some in urban. Some are in manufacturing areas, farming areas, mining areas, and in areas where fishing is a major activity.

Regardless of the individual characteristics of your community, people live there. They are like people in every other community in that they carry on a variety of activities in earning a living, building and maintaining homes and schools, keeping the community a safe and healthful place to live, and so on. Each and every one of these activities has been affected and will continue to be affected by science and technology. *The New Basic Science* helps to make this meaningful to young people by relating the pertinent content of science and the science activities to such problems. Teachers who use *The New Basic Science* should recognize that because communities vary, the way in which communities can be used for educational purposes will also vary. Your school may be in a community where young people could have enriched experiences far beyond some one of those proposed in *The New Basic Science*. Although one text cannot develop fully all possibilities for all communities—the clues to such development are there for you.

Using the community as part of the science course (pp.94 and 475)



CONDUCT INVESTIGATIONS

1. Find out what is being done in your community to save scrap metal, waste-paper, and other materials.

2. Make a survey of the farming area around your community to see what conservation practices are being used.

3. Find out what opportunities exist in your community for people to discover their special abilities and to learn

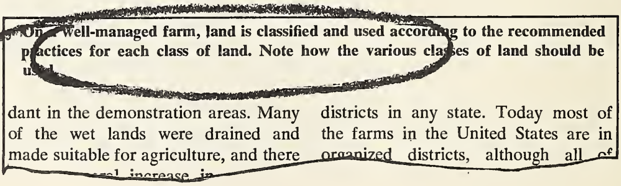
STUDY COMMUNITY SERVICES

1. Make a study of the water system in your community to obtain information about the following:

   a. The source of water
   b. Methods of treating the water
   c. System of distribution
   d. Cost to the consumer
   e. Use of home water softeners

2. Visit the local sewage disposal plant (if there is one in your com-

Material for farming communities (p.437)



On a well-managed farm, land is classified and used according to the recommended practices for each class of land. Note how the various classes of land should be used.

dant in the demonstration areas. Many of the wet lands were drained and made suitable for agriculture, and there

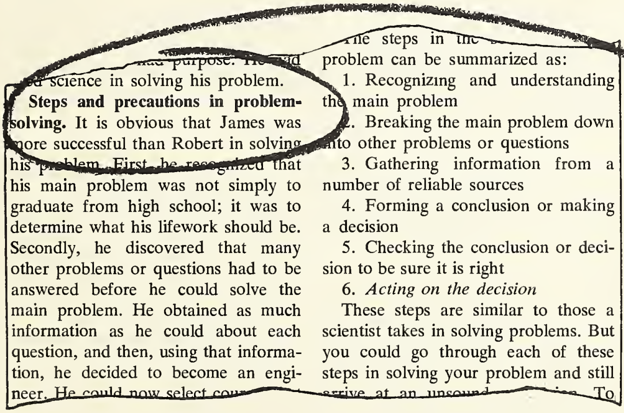
districts in any state. Today most of the farms in the United States are in organized districts, although all

Science in Changing Times

The New Basic Science has been developed with another concern in mind—that of the changing times. The one thing we can be most sure about in the future is change. And yet people in general resist change. We tend to become secure in our established patterns of behavior. We are secure in them because we have found some answers that work. Anything which threatens to change the pattern thus challenges the validity of the old answers and is therefore resisted.

Education has contributed to this state of mind. Too frequently we have thought of education or achievement in school as only learning the answers. True, there are many answers that we need to learn and learn well if we are going to live satisfying lives. But if the entire educational process is spent on learning the answers to problems that have already been solved—what preparation do we give young people to live in the uncertain future? Young people should not be left with the impression that the answers which we now have will hold from now on. They should see science and its impact on our lives as a developing process; they should realize that we are experiencing only one stage in that development.

In order to appreciate this dynamic quality of science, young people should have some experience in working upon problems for which there is presently no available answer, except the one which they will discover. Furthermore, they should understand that some problems, such as maintenance of health, diet and conservation, are persistent ones. They are never solved. We have to keep working upon them. Both the organization of the content in *The New Basic Science* and the nature of the activities included help young people understand better the dynamics of science in changing times.



purpose.

science in solving his problem.

Steps and precautions in problem-solving. It is obvious that James was more successful than Robert in solving his problem. First, he recognized that his main problem was not simply to graduate from high school; it was to determine what his lifework should be. Secondly, he discovered that many other problems or questions had to be answered before he could solve the main problem. He obtained as much information as he could about each question, and then, using that information, he decided to become an engineer. He could now select

steps in

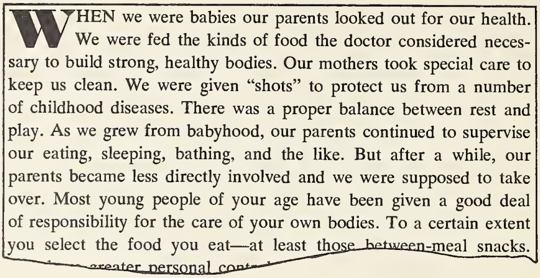
problem can be summarized as:

1. Recognizing and understanding the main problem
2. Breaking the main problem down into other problems or questions
3. Gathering information from a number of reliable sources
4. Forming a conclusion or making a decision
5. Checking the conclusion or decision to be sure it is right
6. *Acting on the decision*

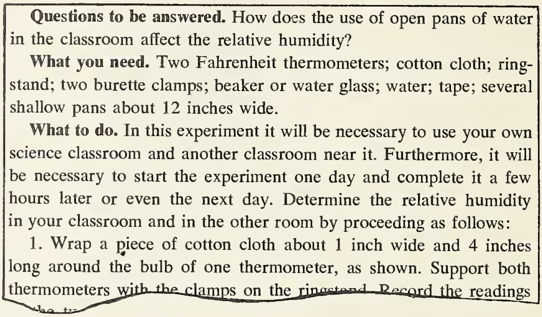
These steps are similar to those a scientist takes in solving problems. But you could go through each of these steps in solving your problem and still arrive at an unsound

Students get practice in using the methods of science to find answers to problems with no other answers (p. 19)

Students are shown that our problems change as we grow older (p. 306) — and that many problems have no "right" answers because situations change (p. 228).



WHEN we were babies our parents looked out for our health. We were fed the kinds of food the doctor considered necessary to build strong, healthy bodies. Our mothers took special care to keep us clean. We were given "shots" to protect us from a number of childhood diseases. There was a proper balance between rest and play. As we grew from babyhood, our parents continued to supervise our eating, sleeping, bathing, and the like. But after a while, our parents became less directly involved and we were supposed to take over. Most young people of your age have been given a good deal of responsibility for the care of your own bodies. To a certain extent you select the food you eat—at least those between-meal snacks.



Questions to be answered. How does the use of open pans of water in the classroom affect the relative humidity?

What you need. Two Fahrenheit thermometers; cotton cloth; ringstand; two burette clamps; beaker or water glass; water; tape; several shallow pans about 12 inches wide.

What to do. In this experiment it will be necessary to use your own science classroom and another classroom near it. Furthermore, it will be necessary to start the experiment one day and complete it a few hours later or even the next day. Determine the relative humidity in your classroom and in the other room by proceeding as follows:

1. Wrap a piece of cotton cloth about 1 inch wide and 4 inches long around the bulb of one thermometer, as shown. Support both thermometers with the clamps on the ringstand. Record the readings

Science Objectives

There are commonly accepted objectives for science teaching. They are stated in many recognized sources.[1] You probably have a syllabus or course of study in your school in which the objectives for general science are formulated. You will find that comparison of the various statements of objectives reveals several major ones to which most of the more specifically stated ones relate. *The New Basic Science* enables you to achieve those objectives. It helps you to direct the learning of your pupils so that they will be able to do the following:

1. Understand those science generalizations that will help them control and adjust to their physical, biological, and social environment.
2. Solve personal, social, and science problems through the application of the attitudes and methods of science.
3. Develop interests in science leading to worth-while recreational and leisure-time activities.
4. Understand vocational possibilities in science.
5. Understand and appreciate the part that science and scientists play in our society.
6. Develop a system of values in which the attitudes and methods of science are viewed in a satisfactory perspective.

---

[1] National Society for the Study of Education. Thirty-first Yearbook, Part I: *A Program for Science Teaching*. Public School Publishing Company. Bloomington, Illinois, 1932.

National Society for the Study of Education. Forty-sixth Yearbook, Part I: *Science Education in American Schools*. Chicago, Illinois: University of Chicago Press, 1947.

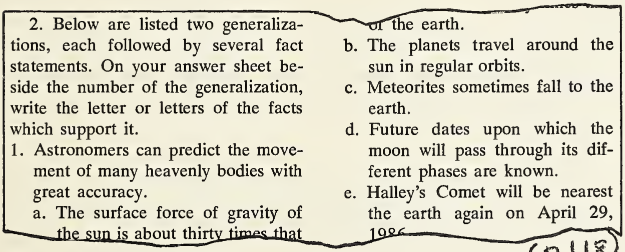
The statements of these objectives may sound good to our pedagogical ears, but they are meaningless unless they are translated into action in the classroom. *The New Basic Science* will help you to put them into action.

Science Facts and Generalizations

Facts are basic to learning science. The pupil is instructed to read the factual statements in the text assignment, recite them the next day, and give them back on tests at the end of the course. In terms of this objective, the student who gives back most facts on the test is judged to have learned most. Many of us have taught for this objective in this way. It was meaningful and to that extent was valid.

But in order for an objective to be valid, it must be judged by other criteria. One such criterion is the extent to which the learning is retained. Here research or experimentation in science teaching can be used to supply the evidence. It has been found that one year after completion of a course in science, the persons who took the course had forgotten about 70 per cent of the specific facts they had learned. A science course, therefore, that emphasizes learning isolated facts is merely educating for forgetting.

This by no means suggests that facts are not important. If we are to understand generalizations, we must use facts. If we are to solve problems scientifically, we must obtain and use reliable facts. Here, however, facts are *used*. They become a



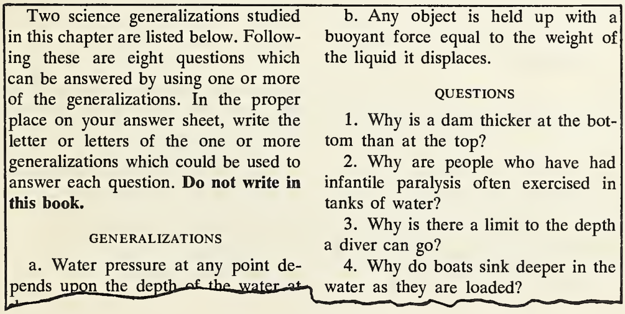
2. Below are listed two generalizations, each followed by several fact statements. On your answer sheet beside the number of the generalization, write the letter or letters of the facts which support it.

1. Astronomers can predict the movement of many heavenly bodies with great accuracy.
   a. The surface force of gravity of the sun is about thirty times that

of the earth.
   b. The planets travel around the sun in regular orbits.
   c. Meteorites sometimes fall to the earth.
   d. Future dates upon which the moon will pass through its different phases are known.
   e. Halley's Comet will be nearest the earth again on April 29, 1986

(p. 118)

Practice in making facts meaningful by relating them to generalizations



Two science generalizations studied in this chapter are listed below. Following these are eight questions which can be answered by using one or more of the generalizations. In the proper place on your answer sheet, write the letter or letters of the one or more generalizations which could be used to answer each question. **Do not write in this book.**

GENERALIZATIONS

a. Water pressure at any point depends upon the depth of the water at

b. Any object is held up with a buoyant force equal to the weight of the liquid it displaces.

QUESTIONS

1. Why is a dam thicker at the bottom than at the top?
2. Why are people who have had infantile paralysis often exercised in tanks of water?
3. Why is there a limit to the depth a diver can go?
4. Why do boats sink deeper in the water as they are loaded?

Not just facts — but application of them to generalizations. (p. 70) means to an end rather than ends in themselves. They are related to generalizations and help the student to understand and solve problems. Let's take an example of one way in which this fact—generalization—problem business works. The pupil may learn the following facts from many different experiences:

1. Praying mantes eat grasshoppers.
2. Grasshoppers eat green plants.
3. Green plants use carbon dioxide in manufacturing food.
4. Living things give off carbon dioxide as a waste product when they use food.
5. Green plants give off oxygen as a waste product when they manufacture food.
6. Grasshoppers and praying mantes need oxygen.

These, as they stand, may be considered facts. If dealt with individually without relation to each other, they are isolated facts. But when they are related, through a guided learning experience, to the generalization, *Living things are interrelated,* they have a different kind of meaning. Furthermore, as more such facts are observed and related to the generalization—the learner's understanding of the generalization grows.

If the learning were left at this point, it might still be academic in terms of making any difference in the lives of boys and girls—in modifying or changing their behavior. Suppose, however, that after these boys and girls have observed that hawks kill chickens and birds, they then raise the reasonable question: Should we kill hawks? Now the generalization, *Living things are interdependent,* comes into action as a basis for making an intelligent decision.

Research has shown that generalizations when learned as described above are not forgotten as are the isolated facts. Some research indicates that one year after the science course, the students who took the course did even better on tests of understanding of generalizations than they did at the completion of the course. The understanding of science generalizations is thus considered a valid objective. They are retained. They can be related to problem situations, and thus serve as guides to intelligent behavior.

The content of *The New Basic Science* is organized around problems in which pertinent facts are related to generalizations, and they in turn to the problem. If you believe that an understanding of the content of science should make young people different, then you must organize your materials and develop the learning techniques toward such an end. If you use it properly, *The New Basic Science* will help you do this.

Science Attitudes and Methods

Research has shown that young people, when properly taught, can develop scientific attitudes and learn to use the methods of science. One problem for the teacher, however, is to translate clearly these attitudes and abilities into behavior or action outcomes. The next problem is not only to plan learning experiences in which young people can see how others act who are exercising these behaviors; it is also to give the young people practice in the behaviors. *The New Basic Science* helps you to meet both these problems, for it includes material and suggested experiences through which the student obtains practice in:

RECOGNIZE ASSUMPTIONS

Bill read in his science book that fuels give off different amounts of heat when they are burned. To gather some evidence to test this statement, he obtained three equal-sized beakers, put the same amount of water in each beaker, and placed each of them on a ringstand. He placed a thermometer in each beaker. Two inches below each beaker he placed a small container. He

scribed above, you would have to accept before you could agree with Bill's conclusion.

1. Ether, alcohol, and gasoline are fuels.
2. The temperature of the water in the beakers was the same before the fuel was burned.
3. Equal amounts of each of the fuels were burned under each beaker.
4. Each

Practice in important problem-solving ability (p. 236)

PERSONAL PROBLEM SOLVING

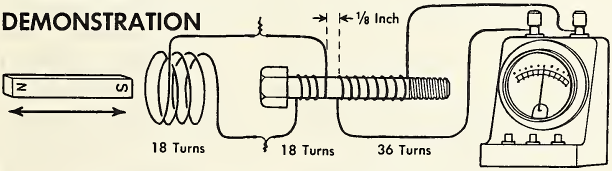
Solving personal problems. You know what the problems of boys and girls of your own age are. Probably most of them are personal problems: How can I improve my appearance? How can I become popular? How can I earn my spending money? How should I select my high-school courses? Such problems are not taken to the science laboratory to be

His only concern was to graduate from high school.

The other boy, James, some time before school started, attempted to find out what a high-school education could mean to him. He discussed the matter with the principal of the high school and also asked the opinions of friends who had graduated from high school. He concluded that his high-school education could prepare him for college work and

Applying methods of science to personal problems (p. 18)

DEMONSTRATION



Generalization to be demonstrated. Whenever an alternating current passes through the primary coil of a transformer, an electromotive force is produced in the secondary coil.

What you need. A magnet; several feet of insulated copper wire; a large iron nail, such as a spike, or a bolt; a galvanometer.

What to do. Set up the equipment, as shown in the drawing above. Then move one pole of a magnet back and forth through the center of the coil attached to the primary coil of the transformer, and observe the action of the galvanometer pointer.

What to observe. How does the movement of the magnet through the coil affect the pointer of the galvanometer? What evidence is there that an electromotive force is being produced?

What does it mean? 1. How does the movement of the pointer of the galvanometer give

guided demonstration experience with practice in the attitudes and methods of science (p. 207)

1. Looking for reliable explanations of phenomena he does not understand.
2. Recognizing problems that need to be solved.
3. Analyzing problems by determining the elements which need to be considered in their solution.

4. Using effectively the skills involved in locating, collecting, organizing, understanding, and testing the reliability of information needed to solve a problem.
5. Devising reliable methods for obtaining evidence to solve problems.
6. Evaluating evidence in terms of its adequacy and reliability, and suspending judgment until reliable evidence can be obtained.
7. Generalizing from related information to form summary statements, hypotheses, and conclusions.
8. Recognizing hypotheses and putting them to appropriate tests before accepting them as conclusions.
9. Selecting pertinent generalizations of science and applying them to the solution of new problems.

Stimulating Science Interests

Children are naturally curious. They ask many questions about the things which they observe in their environment. They seem to be all eyes and ears, with a constant flow of whats, hows, and whys. It is this predisposition to ask questions that we desire to nurture in our science programs. But if as young people progress through the public schools they ask fewer and fewer questions, it would seem that the schools are not making the most of the students' natural interest in what is going on about them. What can we as science teachers do about it?

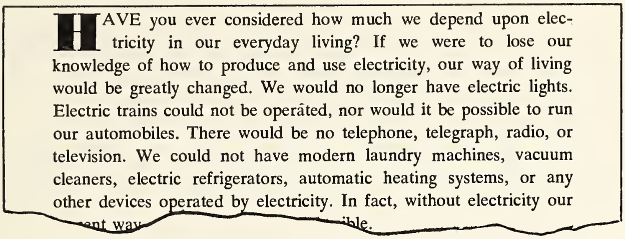
In a recent study of the questions asked by several thousands of children, it was found that questions related to science were twice as numerous as those related to other fields. When one thinks of the many ways in which science and technology are affecting our lives, these results are not at all surprising. But there is evidence to show that as young people progress in school, their interest in science decreases. Where they have a choice, proportionately fewer and fewer of them enroll in science courses. Should not the science program stimulate an interest in science? We believe it should. We further believe that this interest, for those who demonstrate science talent, should lead to socially desirable, personally satisfying, and productive careers in science.

The New Basic Science will help you to stimulate the science interests of pupils in several ways. First, the organization, content, and style of the written material has been designed to get the reader involved. Second, through an enriched variety of guided activities, including selected reading, surveys, observations, demonstrations, and experiments, pupils can become active participants. No one can experience the true thrill of science without becoming actively involved in its processes, and *The New Basic Science* makes every effort to achieve this.

Understanding the Role of Science and Scientists

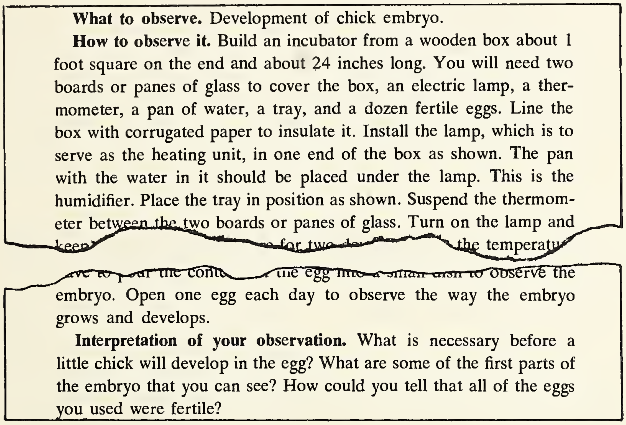
There is a good deal of evidence that people need to understand better the roles that science and the scientist play in our society. Our standard of living, our health status, and our national security have all been achieved through using science to build machines and processes that improve goods and services, to understand the nature of diseases and ways of controlling them, and to develop fearful weapons of destruction.

It is interesting, however, that scientific conquest of the unknown and technical application of what is learned to the improvement of our welfare must be



HAVE you ever considered how much we depend upon electricity in our everyday living? If we were to lose our knowledge of how to produce and use electricity, our way of living would be greatly changed. We would no longer have electric lights. Electric trains could not be operated, nor would it be possible to run our automobiles. There would be no telephone, telegraph, radio, or television. We could not have modern laundry machines, vacuum cleaners, electric refrigerators, automatic heating systems, or any other devices operated by electricity. In fact, without electricity our ent way ible.

Material to get the reader involved (p.196)



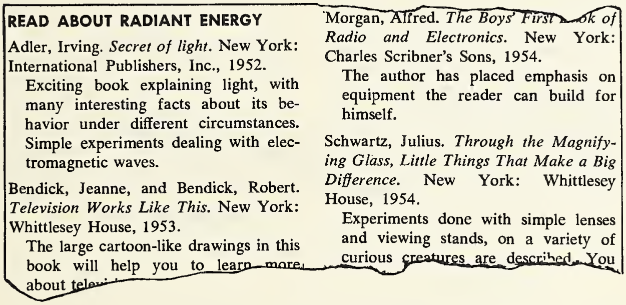
What to observe. Development of chick embryo.

How to observe it. Build an incubator from a wooden box about 1 foot square on the end and about 24 inches long. You will need two boards or panes of glass to cover the box, an electric lamp, a thermometer, a pan of water, a tray, and a dozen fertile eggs. Line the box with corrugated paper to insulate it. Install the lamp, which is to serve as the heating unit, in one end of the box as shown. The pan with the water in it should be placed under the lamp. This is the humidifier. Place the tray in position as shown. Suspend the thermometer between the two boards or panes of glass. Turn on the lamp and keep for two da the temperatu

ave to pour the conte the egg into a small dish to observe the embryo. Open one egg each day to observe the way the embryo grows and develops.

Interpretation of your observation. What is necessary before a little chick will develop in the egg? What are some of the first parts of the embryo that you can see? How could you tell that all of the eggs you used were fertile?

Activities that relate to a common interest of young people—reproduction and growth (p. 377)



READ ABOUT RADIANT ENERGY

Adler, Irving. *Secret of light.* New York: International Publishers, Inc., 1952.
Exciting book explaining light, with many interesting facts about its behavior under different circumstances. Simple experiments dealing with electromagnetic waves.

Bendick, Jeanne, and Bendick, Robert. *Television Works Like This.* New York: Whittlesey House, 1953.
The large cartoon-like drawings in this book will help you to learn more about tele

Morgan, Alfred. *The Boys' First ok of Radio and Electronics.* New York: Charles Scribner's Sons, 1954.
The author has placed emphasis on equipment the reader can build for himself.

Schwartz, Julius. *Through the Magnifying Glass, Little Things That Make a Big Difference.* New York: Whittlesey House, 1954.
Experiments done with simple lenses and viewing stands, on a variety of curious creatures are described. You

Reading to make pupils participate (p. 194)

continuous if the goals we have achieved are to be maintained. During the past twenty years, progress has been so rapid that the new process or technique which was a revolutionary technical discovery yesterday may have questionable value today, and tomorrow may even become obsolete. The new weapons in our own hands promise security; in the hands of an enemy, they confront us with the more difficult problems of defense. The magnitude and variety of machines which make it possible to use our energy resources at astronomical rates make the discovery of new energy resources imperative. The wonder drug which insures protection from one killer microbe may induce a more virulent mutant microbe from which there are presently no wonder drugs to protect us.

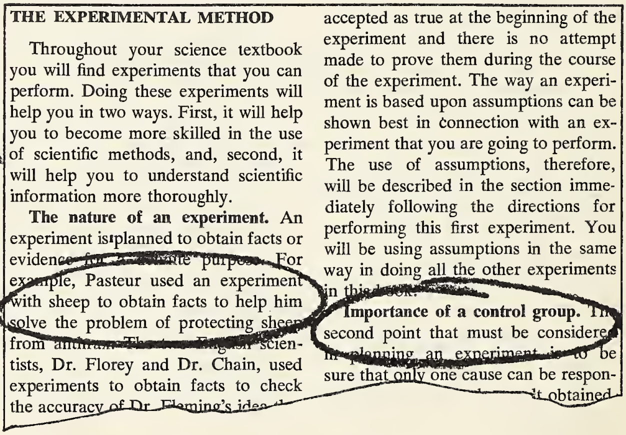
Science has been developed by man. The great discoveries of science have evolved out of man's efforts to interpret the findings of his investigations. The technical applications of these discoveries to the improvement of human welfare have, in turn, been made by man. Since science is man-made, its future development, both theoretical and technical, will depend upon the quality and number of our future scientists. It will also depend upon the willingness of citizens to support the scientific enterprise.

This point of view with respect to science and scientists permeates *The New Basic Science*. It has dictated the basic organization of the book. It has served as one of the criteria for selection and presentation of content and the pupil activities in the book. If you are a science teacher who shares with us the belief that a course in science should help young people to grow in their understanding and appreciation of the part that science and scientists play in our society, then you will find *The New Basic Science* helps you to be successful in your teaching.

Developing Values

Even if it were possible, the schools should not dictate the values by which young people orient their lives. Psychologically young people, like all of us,

The nature of the experimental method developed from the observations of scientists (p. 36)



THE EXPERIMENTAL METHOD

Throughout your science textbook you will find experiments that you can perform. Doing these experiments will help you in two ways. First, it will help you to become more skilled in the use of scientific methods, and, second, it will help you to understand scientific information more thoroughly.

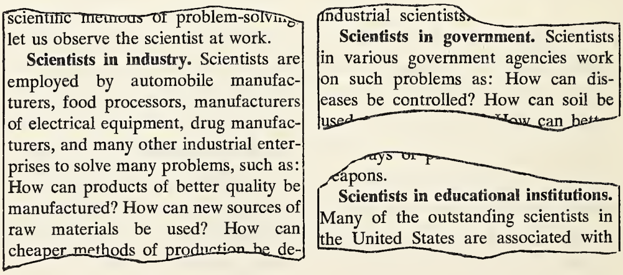
The nature of an experiment. An experiment is planned to obtain facts or evidence for a definite purpose. For example, Pasteur used an experiment with sheep to obtain facts to help him solve the problem of protecting sheep from anthrax. The two English scientists, Dr. Florey and Dr. Chain, used experiments to obtain facts to check the accuracy of Dr. Fleming's idea

accepted as true at the beginning of the experiment and there is no attempt made to prove them during the course of the experiment. The way an experiment is based upon assumptions can be shown best in connection with an experiment that you are going to perform. The use of assumptions, therefore, will be described in the section immediately following the directions for performing this first experiment. You will be using assumptions in the same way in doing all the other experiments in this book.

Importance of a control group. The second point that must be considered in planning an experiment is to be sure that only one cause can be respon-

obtained

The various roles of the modern scientist are considered (pp. 7-8)



scientific methods of problem-solving, let us observe the scientist at work.

Scientists in industry. Scientists are employed by automobile manufacturers, food processors, manufacturers of electrical equipment, drug manufacturers, and many other industrial enterprises to solve many problems, such as: How can products of better quality be manufactured? How can new sources of raw materials be used? How can cheaper methods of production be de-

industrial scientists.

Scientists in government. Scientists in various government agencies work on such problems as: How can diseases be controlled? How can soil be used How can bett

ays of p

eapons.

Scientists in educational institutions. Many of the outstanding scientists in the United States are associated with

A patrolman on a bridge uses special radar equipment to measure the speed of cars on the ← (p. 167)

A meteorologist gives pilots weather information before they take off. A knowledge of the weather ← (p 296)

(p. 510)

Scientists are using tracer elements in medicine to discover and treat certain illnesses of

(p. 335)

This research worker is handling tuberculosis bacilli to be used for study. She uses rubber gloves and a protective glass to avoid coming in contact with the bacilli

The activities of scientists, & their effect on our lives.

evolve their own systems of values out of the many experiences, in and out of school, which they have. And the nature and quality of those experiences determine what the values for each will be. The schools do, however, have the responsibility for broadening and enriching such experiences, through its various curricula, beyond what would be available to young people if there were no schools. Science is unique among the various curricula in giving both breadth and enrichment to the experiences of young people. It is responsible for helping young people to understand how the attitudes and methods of science may relate to the solution not only of strictly scientific problems, but also of personal and social problems. Furthermore, the course must be realistic enough to recognize the

PROBLEM 1. What does science mean to people who are not scientists?

IDEAS ABOUT SCIENCE

Science as a way of doing something. In trying to find out what the term *science* means to people who are not scientists, we might consider how boys and girls use the term. Suppose, for example, that you are discussing a recent basketball victory. Your

At some time one of your friends may have shown little judgment in selecting a suit of clothes or a dress. Perhaps the color was not right, or the style was not suited to the person's figure, or the material was not of good quality, or something else was obviously wrong with the garment. As you

The New Basic Science helps to develop a system of values

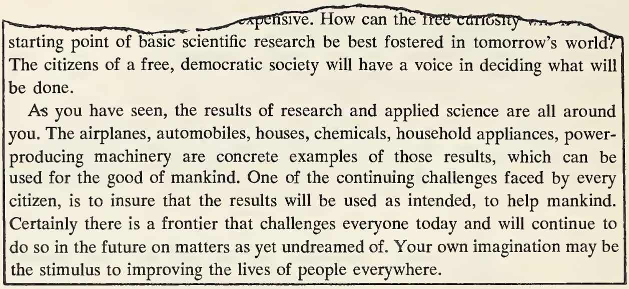
"I AM a boy only thirteen years of age but if I had the opportunity to go into space I would jump at the chance," wrote Walter, one young reader of a series of articles on space travel.

Another, an older reader, wrote in reply to the same articles, "I predict that it will be impossible to produce men willing to let themselves be disembarked a thousand miles above the earth. To put it bluntly: no one is going to be that crazy."

The sun, moon, stars and the vast space between them have held great interest for many people. The mystery which for ages was associated with these bodies caused some people not only to fear them, but often to worship them as well. Even today, when we have more reasonable explanations of what the heavenly bodies are and how they affect the earth

Individual differences — and the curiosity and eagerness of youth (p. 96)

Lasting
values—past,
present, and
future—are
developed
(p 611)



expensive. How can the free curiosity

starting point of basic scientific research be best fostered in tomorrow's world? The citizens of a free, democratic society will have a voice in deciding what will be done.

As you have seen, the results of research and applied science are all around you. The airplanes, automobiles, houses, chemicals, household appliances, power-producing machinery are concrete examples of those results, which can be used for the good of mankind. One of the continuing challenges faced by every citizen, is to insure that the results will be used as intended, to help mankind. Certainly there is a frontier that challenges everyone today and will continue to do so in the future on matters as yet undreamed of. Your own imagination may be the stimulus to improving the lives of people everywhere.

limitations of science; it must make clear its relationship to other ways used by thinking man to get answers to questions which cannot be answered by using science. Since the authors do not assume that the mere study of science achieves these ends, they have provided in *The New Basic Science* many guided experiences for these purposes.

HOW CAN YOU MOST EFFECTIVELY USE *THE NEW BASIC SCIENCE?*

An Overview of *The New Basic Science*

The New Basic Science is divided into thirteen units, each unit representing a broad aspect of the environment or some aspect of man's efforts to control the environment for his welfare. Unit 1 is designed to help the pupil obtain the concept of science as it is used in this book. The meaning of science is examined from the point of view of the scientist, as well as of the non-scientist. In the latter part of the unit, science as a problem-solving activity is emphasized and related to the personal lives of young people.

Some of the important problems which man has solved or must solve in using air, water, and the surface of the earth are taken up in Unit 2. In dealing with these problems, a number of concepts such as the molecular nature of matter, chemical reactions, and work are developed. Because many of the concepts are basic to an understanding of the problems dealt with later in the book, considerable space is given to their development in this unit.

"The Universe" appears as Unit 3 to complete for the pupil a general overview of the material physical environment. Although man cannot exercise the control over heavenly bodies that he does over air, water, and materials on the surface of the earth, he has maintained through the ages an active curiosity about these bodies. This curiosity has led him to speculate about the effects of heavenly bodies upon him and to develop instruments to help him understand better the nature of these bodies.

In Unit 4, "Radiant Energy," the problems involved in obtaining and using electromagnetic radiations such as X-rays, ultraviolet light, visible light, infrared rays, and radio waves are treated in a unified manner. Some of the common characteristics of these forms of energy as well as the ways in which they differ are explained. The concepts developed in this unit lead quite naturally into the next unit on electricity.

The problems of obtaining, controlling, measuring, and using electricity in our homes are taken up in Unit 5. Ways in which direct current is obtained and used are also developed in this unit.

In Unit 6, "Heat," emphasis is placed upon the problems of obtaining heat, measuring it, controlling it for our comfort, and controlling it in cooking and cooling foods. In this unit, an attempt has been made to develop a basic concept of heat which is applied in most of the later units.

The problems of understanding the causes of weather, how it can be forecast, its relation to climate, and how we can adjust to climate and changes in weather are developed in Unit 7. A number of related concepts developed in earlier units are enlarged and applied to the problems in this unit.

In Unit 8, "Health," the problems of keeping the body operating efficiently and protecting it from harmful organisms are dealt with in terms of what young people can do to maintain healthy bodies. The effects of alcohol, tobacco, and narcotics upon health are presented in one of the problems of this unit. Concepts related to the structure and functions of the body, growth, diet, exercise, causes and prevention of diseases are developed in this unit as they are related to the practical problems which people encounter in maintaining strong, healthy bodies.

A number of the important things which people do to or for living things are treated in Unit 9. The subject matter of the unit deals with how living things are propagated, how they are cared for so that we can raise sufficient quantities to meet our needs, and finally how the quality of living things can be improved. A number of important biological concepts are developed in this unit and applied to the problems under consideration.

In Unit 10, "Conservation," the manner in which we have used unwisely our resources of soil, water, minerals, living things, and human beings is presented as a way to help young people recognize the consequences of such unwise use, and to realize the problems facing us in making wiser use of these resources. Although reference is made to conservation in appropriate units throughout the text, in this unit the scientific, social, and economic implications of resource use are treated in a unified manner.

The problems having to do with work and power are treated in Unit 11. These problems deal with types and sources of energy, the way in which machines can be used in controlling energy for doing purposeful work, the use of engines in developing force, and the use of atomic energy. Although some new concepts related to mechanics and atomic energy are developed, a number of the concepts developed in earlier units are reapplied to the problems in this unit.

With the exception of concepts related to sound, most of the material in Unit 12, "Transportation and Communication," is an application of concepts developed earlier to the use of motor vehicles, trains, ships, and aircraft for transportation; and to the use of wire and wireless communication. The way sound is produced and controlled for communication is treated for the first time in one of the chapters of this unit.

In Unit 13 appear the problems of selecting and using materials for constructing many things, including buildings, bridges, clothing, and machines. This appears as the last major unit of the book because a large number of concepts developed earlier are applied to the problems in this unit. Furthermore, the material in this unit points up many of the achievements of scientists, and leads into the final section of the book: "No New Worlds to Conquer?"

This final section or epilogue on the future of science completes the picture, built up in the thirteen units of the book, of science as a *continuing* process. In this section an attempt is made to help the pupil understand that, since science is an activity of human beings, its future will be determined by what we, both scientist and non-scientist, decide it shall be. The book ends with this hopeful challenge to young people.

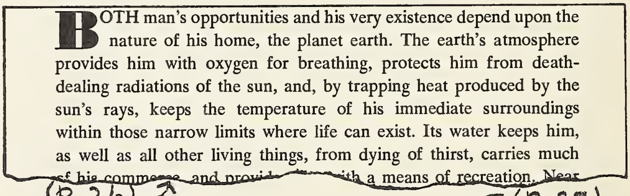
This overview of the book has been prepared to give you, the teacher, a general feeling of the direction in which this book moves. It is desirable that you sense this movement within the book in order to make most effective use of it as a learning guide for science pupils.

The Organization of *The New Basic Science*

Now that we have completed an overview of the book, let's examine its unit organization. Each unit is introduced with a picture and a one-page introduction. You will note from the table of contents (pages iii-v [1]) that each unit is divided into two or more chapters. Each chapter, in turn, has its own introduction, and is divided into two or more problems. As you read the problems for each chapter or unit, note the way in which, individually or collectively, the problems emphasize action—that is, something is done about the problem.

The material in *The New Basic Science* has been selected and organized so that it leads the student to understand what *has been done* or what *can be done* in the future to solve the problem.

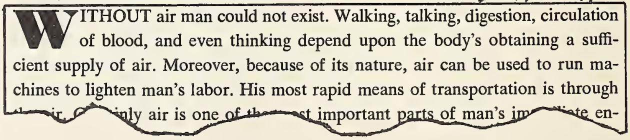
The unit and chapter introductions point up the significance of the material



BOTH man's opportunities and his very existence depend upon the nature of his home, the planet earth. The earth's atmosphere provides him with oxygen for breathing, protects him from death-dealing radiations of the sun, and, by trapping heat produced by the sun's rays, keeps the temperature of his immediate surroundings within those narrow limits where life can exist. Its water keeps him, as well as all other living things, from dying of thirst, carries much his comme and provi ith a means of recreation. Near

(p. 26)

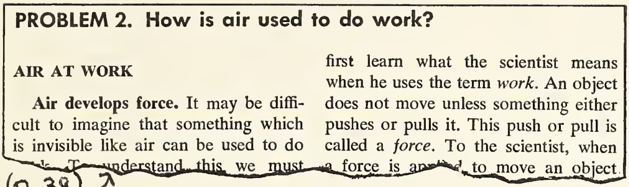
(p. 27)



WITHOUT air man could not exist. Walking, talking, digestion, circulation of blood, and even thinking depend upon the body's obtaining a sufficient supply of air. Moreover, because of its nature, air can be used to run machines to lighten man's labor. His most rapid means of transportation is through inly air is one of st important parts of man's im en-

---

[1] Unless otherwise noted, page references are to the text *The New Basic Science*.



PROBLEM 2. How is air used to do work?

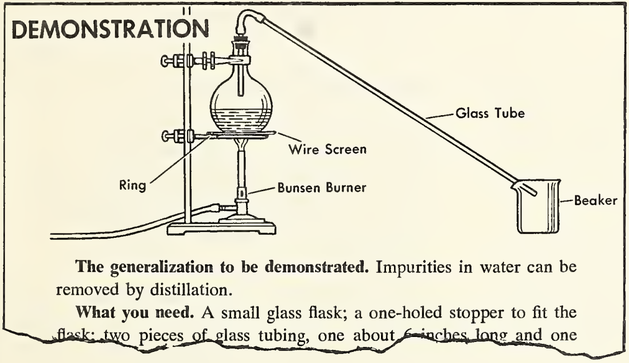
AIR AT WORK

Air develops force. It may be difficult to imagine that something which is invisible like air can be used to do k. To understand this we must first learn what the scientist means when he uses the term *work*. An object does not move unless something either pushes or pulls it. This push or pull is called a *force*. To the scientist, when a force is ap d to move an object

(p. 39)

Each problem develops the concepts essential to understanding the problem

(p. 58)



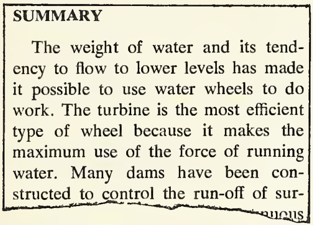
DEMONSTRATION

The generalization to be demonstrated. Impurities in water can be removed by distillation.

What you need. A small glass flask; a one-holed stopper to fit the flask; two pieces of glass tubing, one about 6 inches long and one

Activities in each problem develop understanding of the methods of science.

(p. 68)

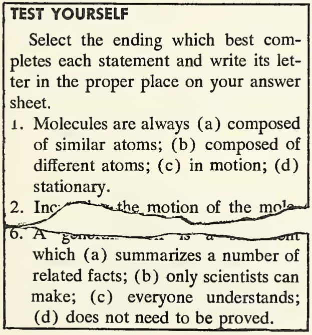


SUMMARY

The weight of water and its tendency to flow to lower levels has made it possible to use water wheels to do work. The turbine is the most efficient type of wheel because it makes the maximum use of the force of running water. Many dams have been constructed to control the run-off of sur- nuous

Summaries at end of each problem state generalizations in the problem

(p. 47)



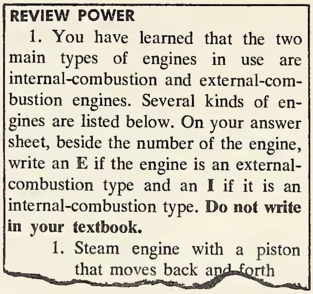
TEST YOURSELF

Select the ending which best completes each statement and write its letter in the proper place on your answer sheet.

1. Molecules are always (a) composed of similar atoms; (b) composed of different atoms; (c) in motion; (d) stationary.
2. Inc the motion of the mol
6. A which (a) summarizes a number of related facts; (b) only scientists can make; (c) everyone understands; (d) does not need to be proved.

A self-test at end of each problem checks the pupils' understanding of material in the problem.

Chapter Activities test knowledge, understanding of generalizations, ability to apply facts

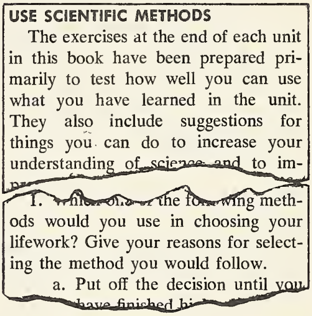

REVIEW POWER

1. You have learned that the two main types of engines in use are internal-combustion and external-combustion engines. Several kinds of engines are listed below. On your answer sheet, beside the number of the engine, write an **E** if the engine is an external-combustion type and an **I** if it is an internal-combustion type. **Do not write in your textbook.**

1. Steam engine with a piston that moves back and forth

(p.512)

Unit Activities test the ability to use the methods of science to apply generalizations.


USE SCIENTIFIC METHODS

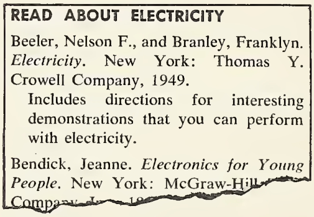
The exercises at the end of each unit in this book have been prepared primarily to test how well you can use what you have learned in the unit. They also include suggestions for things you can do to increase your understanding of science and to im-

1. Which one of the following methods would you use in choosing your lifework? Give your reasons for selecting the method you would follow.

a. Put off the decision until you

(p.21)

Annotated bibliographies provide readings to suit various abilities,


READ ABOUT ELECTRICITY

Beeler, Nelson F., and Branley, Franklyn. *Electricity*. New York: Thomas Y. Crowell Company, 1949.
Includes directions for interesting demonstrations that you can perform with electricity.

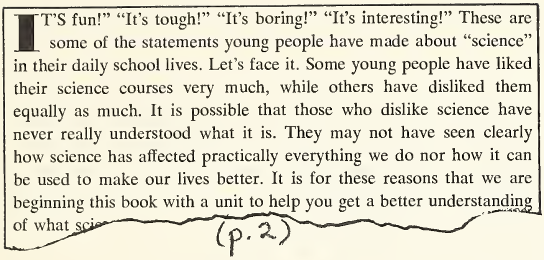
Bendick, Jeanne. *Electronics for Young People*. New York: McGraw-Hill

(p.223)

The New Basic Science lends itself especially well to the problem-solving approach in teaching general science, but it can be adapted to a number of other approaches to the teaching of the subject. Although there is probably no one way of using *The New Basic Science* that would work equally well for all teachers, there are a number of general suggestions which the authors believe teachers using the book will find helpful.

Introducing Young People to *The New Basic Science*

The manner in which young people are introduced to the science course which this book represents is an important factor in the success of the course. Unit 1 has been prepared as an introduction to the study of this general science course, thus relieving the teacher of having to improvise experiences that would be suitable for an introduction to the course.



IT'S fun!" "It's tough!" "It's boring!" "It's interesting!" These are some of the statements young people have made about "science" in their daily school lives. Let's face it. Some young people have liked their science courses very much, while others have disliked them equally as much. It is possible that those who dislike science have never really understood what it is. They may not have seen clearly how science has affected practically everything we do nor how it can be used to make our lives better. It is for these reasons that we are beginning this book with a unit to help you get a better understanding of what sci

(p. 2)

A discussion of the introduction makes a stimulating approach to the material

After the introduction has been read, such questions as the following will bring forth lively and purposeful discussion:

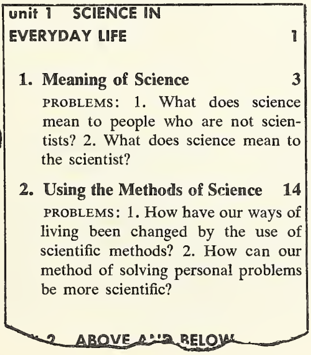
1. What have you read, heard, or seen lately which would support the idea that science is important in our lives today?
2. What are some of the devices and services you use daily that were made possible through science?
3. When you use the term *science* as you have in the above, what does it mean to you?

Do not attempt to judge the pupils' responses to the above questions as right or wrong. Encourage them to express themselves freely on these or similar questions. In their discussion, help them relate experiences which they have had to the questions being discussed. In this way you can begin to learn about their backgrounds as individuals. After a discussion of the third question above, the class should be ready to begin study of the first unit.

The Table of Contents and the Chapter Introductions

In preparing to study Unit 1, as well as each of the subsequent units, first, have the pupils get an overview of the problems that will be taken up in the unit. This can be done by turning to page iii of the Table of Contents, and reading the chapter headings for Unit 1.

(p. iii)



unit 1 SCIENCE IN EVERYDAY LIFE 1

1. Meaning of Science 3
PROBLEMS: 1. What does science mean to people who are not scientists? 2. What does science mean to the scientist?

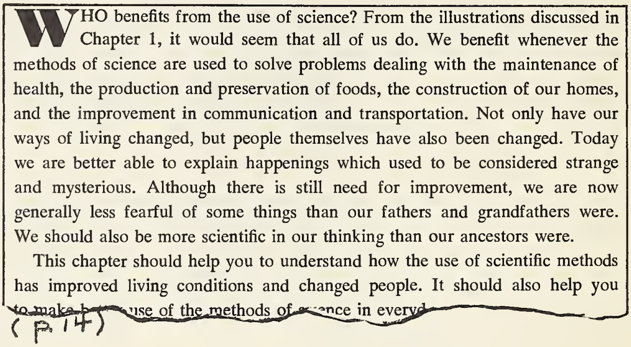
2. Using the Methods of Science 14
PROBLEMS: 1. How have our ways of living been changed by the use of scientific methods? 2. How can our method of solving personal problems be more scientific?

2 ABOVE AND BELOW

Use the Table of Contents to give students an overview of Problems in the Unit, and to show how the Table of Contents should be used

Next, have the pupils open their books to page 3, to read the chapter introductions. You might have them also turn to the introduction for Chapter 2 on page 14, and examine it.

Point out that each chapter introduction relates problems to students' own interests.



WHO benefits from the use of science? From the illustrations discussed in Chapter 1, it would seem that all of us do. We benefit whenever the methods of science are used to solve problems dealing with the maintenance of health, the production and preservation of foods, the construction of our homes, and the improvement in communication and transportation. Not only have our ways of living changed, but people themselves have also been changed. Today we are better able to explain happenings which used to be considered strange and mysterious. Although there is still need for improvement, we are now generally less fearful of some things than our fathers and grandfathers were. We should also be more scientific in our thinking than our ancestors were.

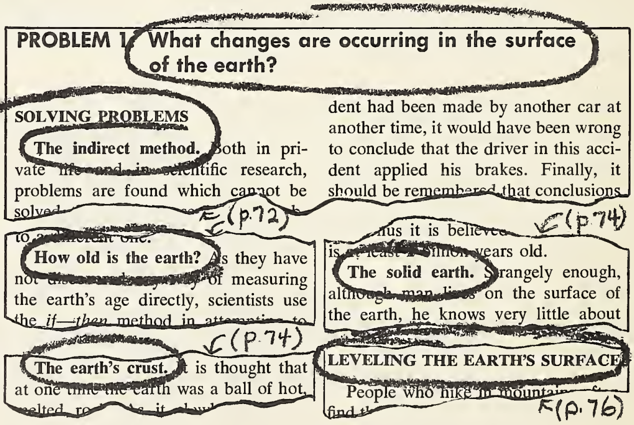
This chapter should help you to understand how the use of scientific methods has improved living conditions and changed people. It should also help you to make b use of the methods of nce in everyd

(p. 14)

Headings and Subheadings

Now the pupils should be ready to go back to Problem 1, page 4, and see how the text material is broken up into headings and subheadings. For example, Problem 1 is broken up into two headings—"Ideas about science" and "Summary." The first heading, "Ideas about science," is further broken down into the following subheadings: "Science as a way of doing something," "Science as truth or authority," "Science as a kind of magic," "Science as a fearful force," "Science as information or knowledge." The pupils should understand that these subheadings are really five ideas about science, and that by reading the headings before they read the text, they can get a general idea of what is included in the text under that problem.

Have students make a careful study of headings and analyze the content of a chapter before reading it.



PROBLEM 1 What changes are occurring in the surface of the earth?

SOLVING PROBLEMS

The indirect method. Both in private life and in scientific research, problems are found which cannot be solved

(p. 72)

to

How old is the earth? As they have not of measuring the earth's age directly, scientists use the *if—then* method in

(p. 74)

The earth's crust. It is thought that at one time the earth was a ball of hot, melted

dent had been made by another car at another time, it would have been wrong to conclude that the driver in this accident applied his brakes. Finally, it should be remembered that conclusions

(p. 74)

hus it is believed is years old.

The solid earth. Strangely enough, although man lives on the surface of the earth, he knows very little about

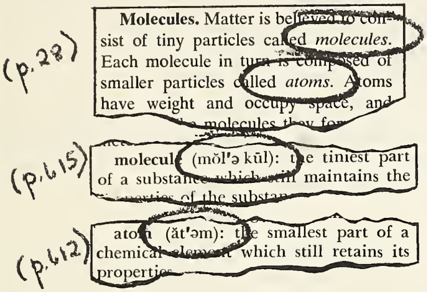
LEVELING THE EARTH'S SURFACE

People who hike in mountain find

(p. 76)

Defining and Pronouncing New Words

In the exploration of Problem 1, as a typical problem in *The New Basic Science,* it should be pointed out that certain words such as *science, scientific, quinine, sulfanilamide,* and *penicillin* are italicized.



(p.28)

Molecules. Matter is believed to consist of tiny particles called *molecules.* Each molecule in turn is composed of smaller particles called *atoms.* Atoms have weight and occupy space, and

(p.615)

molecule (mŏl'ə kūl): the tiniest part of a substance which still maintains the

(p.612)

atom (ăt'əm): the smallest part of a chemical element which still retains its propert

Such new words when first introduced are defined in text and/or glossary, where pronunciation is also shown.

It might be educationally desirable to go through the same process in class with *sulfanilamide* and *penicillin.*

Using Pictures

Pictures in this text can aid the reader in his learning if he knows how to use them and is encouraged to do so. As a part of introducing the book, the pupils should examine the pictures in Problem 1. After they have observed the pictures and read the captions, pupils should be asked to determine what ideas represented by the subheadings already identified are illustrated in each picture. The picture on page 3 is an illustration of science as a kind of magic. The one on page 4 is an illustration of science as a way of doing something and the one on page 6 is a symbol of science as a fearful force. The pupils might be asked how they could use the bulletin board to illustrate the other two ideas about the meaning of science, i.e., science as authority and science as knowledge.

It might be desirable at this time to give the pupils an overview of the more than 500 illustrations in *The New Basic Science*. It should be pointed out that each illustration has been selected to help the pupil get a better understanding of the material to be studied in each problem. He should read carefully the complete caption appearing with each illustration as a part of his observation of the illustration. Research has shown that such guided use of illustrations pays learning dividends.

In drawings such as the one on page 50, labels and arrows are used to represent water soaking into the earth and water evaporating. In order to get the most out of such a drawing, pupils must learn how to use both the labels and symbols. The ability to interpret drawings is an important learning in general science, and teachers should give young people supervised practice in such activities. Drawings may also be used to check pupils' understandings of a generalization. A good example to be used in this way is the drawing on page 432. The last sen-

Discuss pictures with their informative captions Have pupils identify the ideas in them

Oxygen is used in burning fuel such as the wood in this camp fire, with carbon dioxide and water vapor given off. Our bodies also require oxygen to obtain energy from the food we eat and give off carbon dioxide and water vapor as wastes.

(p. 31)

The diagram shows how an electric field affects the rays from radium. Alpha (helium nuclei) travel up to 12,000 miles per second, Beta from 80,000 to 180,000 miles per second, and Gamma at the speed of light.

(p 503)

(p. 64)

The three types of water wheels, from left to right, are overshot, undershot, and breast. The weight of water in the buckets is the force turning the overshot wheel. The swift movement of water turns the undershot wheel. The breast wheel is turned by a combination of the forces used in the other two.

tence of the caption is an important generalization pertaining to soil-forming processes. When the class gets to this unit, use the drawing as an individual or class exercise to determine how well pupils understand the generalization. This can be done by asking pupils to identify those parts of the drawing that illustrate or support the generalization and to explain how they do it.

Summaries and Summary Generalizations

Each sentence in the summary on page 6 is an important generalization that has been developed in the problem. It is important that the pupils understand these generalizations after studying the problem. Each of the problems in *The New Basic Science* has such a summary. In the introductory discussion of Problem 1, Chapter 1, ask pupils to read the summary on page 6, and explain its purpose to them. To emphasize the idea that each sentence is a generalization which has been developed in the text, ask pupils to select one of the generalizations and examine the textual material for Problem 1 to find the section in which information supporting that generalization is presented.

Use summaries to test pupils' understanding of generalizations—and their ability to make their own.

SUMMARY

Because of the nature of science and the number of ways in which it is used, there are many ideas about its meaning. We have seen that the term *science* is commonly used with five different meanings: (1) Science represents facts and is therefore an authority. (2) It is an exact or effective way of doing something. (3) It resembles magic because it seems to perform wonders. (4) It is a force to be feared because of the destructive ways some of its

(p. 6)

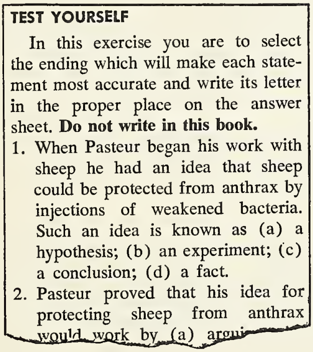
Do not assume that pupils will learn how to make effective use of summaries in *The New Basic Science* by the one exercise described here. Repeat similar exercises at intervals throughout the course. If this is done, pupils can soon be taught to write summary generalizations in their own words. This is one of the objectives mentioned earlier for which all science teachers should strive. Through this kind of activity pupils get experience in examining relationships among factual data and stating those relationships as generalizations. A technique you may later use to encourage this kind of activity is to select one of the summaries and formulate questions which, when answered in complete sentences, would bring out the generalizations similar to those in the summary. You can then give these questions to pupils to answer as they study the problem. The first few times this technique is used, it would be desirable to carry out the activity as a class exercise.

It should be pointed out here that the generalizations in *The New Basic Science* are of two types. One type of generalization is the science principle type, such as the one stated on page 42: ". . . when the rate of flow of a fluid is increased, its sidewise pressure decreases." It is necessary to understand this generalization in order to understand how an airplane can fly. The other type of generalization states how man uses the science principle. An example of this type is stated in the summary on page 45: Air can be made to work "by making air molecules move faster in one place than another, thus causing differences in air pressure." You can see that an understanding of both types of generalizations is a desirable objective of science teaching.

Self-Tests

When the first self-test, pages 6 and 7, is introduced, it is suggested that the pupils and the teacher read together the two paragraphs in which directions for taking the test are given.

(p.12)



TEST YOURSELF

In this exercise you are to select the ending which will make each statement most accurate and write its letter in the proper place on the answer sheet. **Do not write in this book.**

1. When Pasteur began his work with sheep he had an idea that sheep could be protected from anthrax by injections of weakened bacteria. Such an idea is known as (a) a hypothesis; (b) an experiment; (c) a conclusion; (d) a fact.
2. Pasteur proved that his idea for protecting sheep from anthrax would work by (a) argu

Make pupils understand that the self tests are prepared for checking their comprehension of the science used in the problem.

For example, the test on pages 6 and 7 will help pupils to see how well they can relate certain statements about science to the five meanings of science that were explained in the textual material. Note the problem-end test on page 12. This is a test for recall and understanding of specific information dealt with in Problem 2 of Chapter 1. Most of the problem-end tests in *The New Basic Science* are of this type. After pupils have read the second paragraph of instructions for taking the test on page 7, there should be some common understanding of how and where answers to the test will be recorded. If pupils are expected to keep a notebook, a special section might be reserved in each unit for answer sheets. There should also be some agreement on the form for answer sheets.

After pupils have taken the test, their answers should be checked with those of the key (pages 52–62 in this manual). Then ask each pupil to write a statement of what the test showed him about his learning, and another statement regarding what he intends to do about it in his future study. Such exercises will help the pupil to realize the real value of the self-tests. He will see that the self-tests aid him to make his learning in science more effective.

Preparing Pupils for Studying Problems in *The New Basic Science*

Before each of the remaining problems in *The New Basic Science* is studied, use an appropriate introduction and overview. The introduction should not necessarily follow the same form as the one previously described for Problem 1, but you should consider certain basic questions in preparing whatever plan you propose to use. These questions include:

1. Why is it important to study the chapter and unit in which this problem appears?
2. How is this problem related to other problems in this chapter or unit?
3. How can the pupil get the most out of his study of this problem?

Do not overlook the possibilities of using movies, newspaper clippings, articles from magazines, current happenings, and recent experiences of pupils as means of helping pupils see the importance of studying the problems in *The New Basic Science*. For example, the drives that are carried on in some cities for smoke control could be used to point up the importance of the problem on page 28: How do we provide good air for breathing? On pages 21–22 of this manual, the way in which a motion picture can be used for this purpose is discussed. A discussion with the school nurse or a survey of absences from school might provide a meaningful setting for studying Unit 8 on Health.

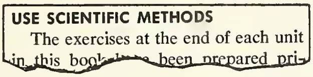
Chapter-End Tests

After a study of the two problems in Chapter 1 has been completed, the review exercises or tests on page 13 should be completed. As explained on page 13, exercises such as these appear at the end of each chapter to help the pupil check his understanding of selected ideas or generalizations developed in the chapter, and to give him practice in applying science in his everyday living. These exercises may be done as a class exercise or as an individual assignment. If done as an individual assignment, there should be some class discussion of the items after each individual has prepared his answers, and you have them checked with the key in this manual. Questions raised by pupils in such discussions are extremely important in promoting the learnings which these exercises have been designed to test. Encourage free and critical discussion of pupils' responses to these test exercises. Avoid saying that such and such an answer is correct merely because it is listed in the key, but try to help pupils arrive at a critical judgment regarding reasons for one answer's being better than another.

Unit-End Activities

The activities suggested at the end of Unit 1 on pages 21–23 are of several types.

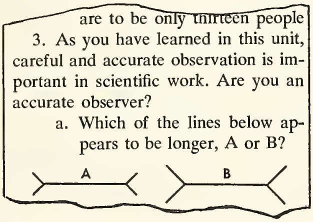
(p.21)



USE SCIENTIFIC METHODS

The exercises at the end of each unit in this boo been prepared pri-

(p.22)

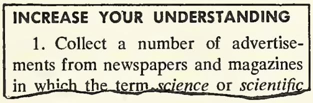


are to be only thirteen people

3. As you have learned in this unit, careful and accurate observation is important in scientific work. Are you an accurate observer?

a. Which of the lines below appears to be longer, A or B?

(p.22)



INCREASE YOUR UNDERSTANDING

1. Collect a number of advertisements from newspapers and magazines in which the term *science* or *scientific*

Some test how well the pupil can use what he has learned in the unit. Others increase his understanding of science, or improve his ability to use methods of science.

It is recommended that unit tests be used in the way suggested for chapter-end tests. It seems desirable to repeat here that critical pupil-teacher discussion of pupils' responses to these items are valuable learning experiences.

The suggested activities (pages 22 and 23) for increasing the pupils' understanding of the meaning and use of science may be used in several ways:

Have all members of the class engage in each activity.

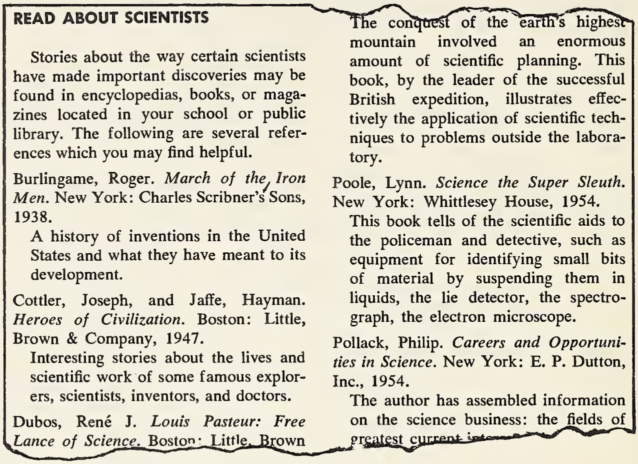
Or form four committees of pupils, each taking responsibility for one of the activities.

Or assign to selected pupils who require more activity than the average pupil one or more of the activities.

Regardless of how these activities are used, some sharing of experiences with others in the class would be desirable.

Unit Bibliographies

The bibliographies of books and pamphlets which appear at the end of each unit have been carefully prepared to encourage pupils to read beyond the material in their texts. Each reference is annotated with a sentence or two that tells the pupil why the book would be a good one to read. As pupils study *The New Basic Science,* they should raise questions about aspects of the unit which interest them particularly, and which they desire to pursue further. The bibliographies at the end of each unit should help to meet these needs for additional material. If a special reference is not in your school library, individuals or a committee of pupils might be asked to examine it in the public library in your community to see if it contains the information which answers the question. Although all pupils should be encouraged to become acquainted with one or more of the references listed at the end of each unit, those pupils who require more than the text to satisfy their interests might be given special assignments in these references. If possible, give them an opportunity to share what they have read with others in the class. It has been found that learning in science can be greatly enhanced by extensive reading. Teachers, however, must point the way and supply generous amounts of encouragement.



READ ABOUT SCIENTISTS

Stories about the way certain scientists have made important discoveries may be found in encyclopedias, books, or magazines located in your school or public library. The following are several references which you may find helpful.

Burlingame, Roger. *March of the Iron Men.* New York: Charles Scribner's Sons, 1938.
A history of inventions in the United States and what they have meant to its development.

Cottler, Joseph, and Jaffe, Hayman. *Heroes of Civilization.* Boston: Little, Brown & Company, 1947.
Interesting stories about the lives and scientific work of some famous explorers, scientists, inventors, and doctors.

Dubos, René J. *Louis Pasteur: Free Lance of Science.* Boston: Little, Brown

The conquest of the earth's highest mountain involved an enormous amount of scientific planning. This book, by the leader of the successful British expedition, illustrates effectively the application of scientific techniques to problems outside the laboratory.

Poole, Lynn. *Science the Super Sleuth.* New York: Whittlesey House, 1954.
This book tells of the scientific aids to the policeman and detective, such as equipment for identifying small bits of material by suspending them in liquids, the lie detector, the spectrograph, the electron microscope.

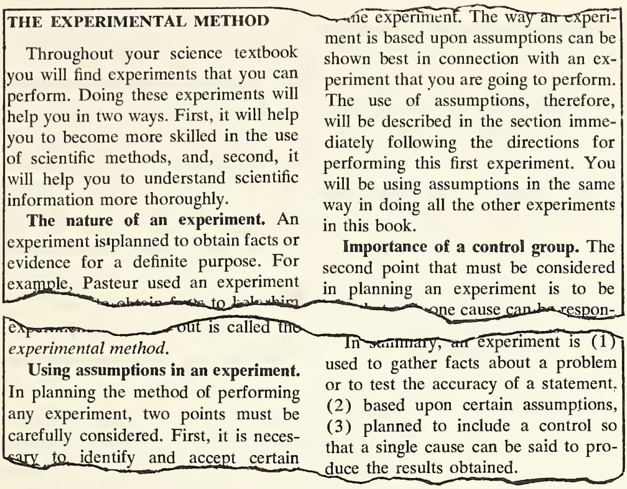
Pollack, Philip. *Careers and Opportunities in Science.* New York: E. P. Dutton, Inc., 1954.
The author has assembled information on the science business: the fields of greatest current

These lists fill the need for additional material, and provide a way to take care of individual differences. (p. 23)

Wherever general science teachers have the responsibility of selecting books for classroom or school library, they will find the thirteen bibliographies in *The New Basic Science* an excellent source from which to choose. The references listed in each bibliography provide for a wide range of reading ability.

Experiments, Demonstrations, and Observations

Experiments, demonstrations, and observations are included in *The New Basic Science* at the ends of problems where such activities are most appropriate. A distinction is made in *The New Basic Science* between experiments and other activities, such as demonstrations and simple observations, which may be carried out to get information. The characteristics of experiments emphasized in this text are set forth on page 36.



THE EXPERIMENTAL METHOD

Throughout your science textbook you will find experiments that you can perform. Doing these experiments will help you in two ways. First, it will help you to become more skilled in the use of scientific methods, and, second, it will help you to understand scientific information more thoroughly.

The nature of an experiment. An experiment is planned to obtain facts or evidence for a definite purpose. For example, Pasteur used an experiment

out is called the *experimental method.*

Using assumptions in an experiment. In planning the method of performing any experiment, two points must be carefully considered. First, it is necessary to identify and accept certain

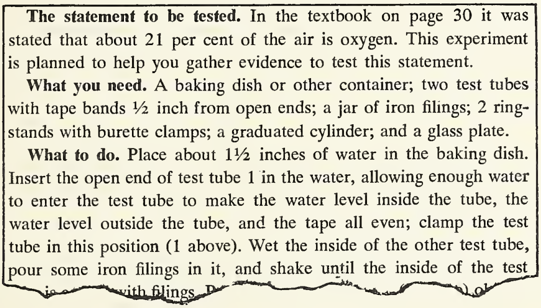
ne experiment. The way an experiment is based upon assumptions can be shown best in connection with an experiment that you are going to perform. The use of assumptions, therefore, will be described in the section immediately following the directions for performing this first experiment. You will be using assumptions in the same way in doing all the other experiments in this book.

Importance of a control group. The second point that must be considered in planning an experiment is to be

one cause can be respon-

In summary, an experiment is (1) used to gather facts about a problem or to test the accuracy of a statement, (2) based upon certain assumptions, (3) planned to include a control so that a single cause can be said to produce the results obtained.

give a whole class session to reading and discussing this important material with pupils (p 36)



The statement to be tested. In the textbook on page 30 it was stated that about 21 per cent of the air is oxygen. This experiment is planned to help you gather evidence to test this statement.

What you need. A baking dish or other container; two test tubes with tape bands ½ inch from open ends; a jar of iron filings; 2 ring-stands with burette clamps; a graduated cylinder; and a glass plate.

What to do. Place about 1½ inches of water in the baking dish. Insert the open end of test tube 1 in the water, allowing enough water to enter the test tube to make the water level inside the tube, the water level outside the tube, and the tape all even; clamp the test tube in this position (1 above). Wet the inside of the other test tube, pour some iron filings in it, and shake until the inside of the test

Then have the class do the experiment which follows (p 37)

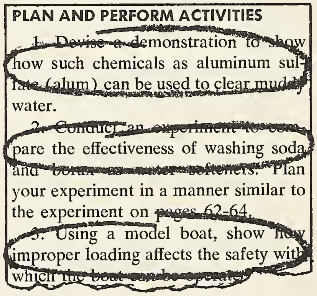
Carry out this first experiment as a class project, allowing sufficient time to discuss questions stated in the instructions for the experiment as well as those raised by pupils. The textual material, "What to look for in the Experimental Method" on page 38, should be included in the discussion. In each experiment, encourage pupils to make sure they know what question is being answered or what statement is being tested by the experiment. Encourage them to examine critically the evidence obtained from the experiment and always to ask themselves the question, *Can I accept this evidence as a final answer to the question or conclusive proof of the statement?*

An example here will help make this important aspect of the experimental method clear. A science instructor wanted to demonstrate to his class that soil contains air. He filled a large flask about three-quarters full of soil. He then poured water into the flask. As some water entered the soil, large bubbles appeared in the water above it. The class was asked to state what this evidence proved. One member of the class said it proved that there was air in the soil, and it appeared that the class was going to accept this as final. The instructor countered with the question, "Is what you have observed here conclusive proof that soil contains air?" This question challenged the class to think. One member said he couldn't accept it as proof because he wasn't sure the bubbles coming out of the water were air. Another said that even though those bubbles were air bubbles, how did you know that all soils would react the same as this soil. Still another said that the bubbles might be caused by a gas released by some chemical reaction in the soil when water entered it. The instructor pointed out that before some members of the class could accept the evidence as proof, they would have to accept certain things as being true. In other words, these were the *assumptions* which they recognized that a person would have to accept as true before he could accept the evidence as conclusive proof that soil contains air. There were a number of the class who said that they were unwilling to accept these assumptions—they wanted to test them.

Teachers should recognize that there are few experiments or demonstrations in science classes that are conclusive proof of whatever it is they are trying to prove. This does not mean that you should exclude experiments as learning experiences in science; it means rather that whenever experiments are done, it is essential to guide the pupil to recognize and evaluate the assumptions in the experiment. It is for this reason that some of the assumptions in most of the experiments and demonstrations of *The New Basic Science* are listed. Encourage pupils to look for others and to evaluate each assumption in terms of its reasonableness.

The experiments and demonstrations presented in *The New Basic Science* guide the pupils' attention to purpose, materials, procedure, conclusions, and assumptions. This has been done not with the intention of making these activities mechanical, but rather to emphasize the importance of concentrating conscious thought upon these aspects of experimentation. In various places throughout the book, pupils are asked to plan experiments and demonstrations.

From such exercises you can appraise the pupils' ability to provide adequately for each aspect of experimentation.



PLAN AND PERFORM ACTIVITIES

1. Devise a demonstration to show how such chemicals as aluminum sulfate (alum) can be used to clear muddy water.

2. Conduct an experiment to compare the effectiveness of washing soda and borax as water softeners. Plan your experiment in a manner similar to the experiment on pages 62-64.

3. Using a model boat, show how improper loading affects the safety with which the boat can be operated.

(p. 73)

If a notebook is kept, the experiments and demonstrations planned by the pupils should be recorded in it in complete form.

Materials and equipment that will be needed to carry out the experiments, demonstrations, and observations in *The New Basic Science* are listed on pages 47–51 of this manual. Following this list are the names and addresses of supply houses from which the more uncommon materials may be obtained. Much of the material, as well as the equipment, can be obtained from homes, five-and-ten-cent stores, grocery stores, hardware stores, and drugstores. Pupils learn desirable skills by helping to plan and obtain the materials used in their science classes. Wherever possible, they should be encouraged to assist.

Motion Pictures

Although no reference has been made in *The New Basic Science* to motion pictures, they may have an important place in science teaching. They were not listed in the text, because it is primarily a responsibility of the teacher to get such materials. Most schools have projection equipment, but few schools are financially able to maintain a film library from which films may be obtained at the exact time they would be educationally most functional. Furthermore, many general science teachers are unable to preview films before ordering them for use in their classes. To help you meet some of the problems connected with selecting films for use with *The New Basic Science,* a selected list of films for each unit, along with the names and addresses of sources are given on pages 41–47 of the manual. These sources will either supply you with the films or they will furnish the name and address of the distributor nearest your school from which you can obtain the films.

Films may be used for various purposes. Some films may serve as a very good introduction to a new unit. An example is a film such as *The River,* which can be used as a most effective introduction to the unit on conservation. In preparing pupils to observe such a film, about all that needs to be done is to point out that the film is being used to help them recognize the importance of certain problems. After the film has been shown, pupils should be encouraged to state their reactions to the film and to indicate problems which the film emphasized.

Films may also be used for collecting additional evidence for one of the problems being studied. When you use a film for this purpose, prepare pupils for observing the film by stating questions which the film will answer for them, and by encouraging them to try to keep these questions in mind as they watch the film. Pupils should not be asked to try to keep notes while a film is being shown. After the film is shown, the pupils should see how many of the questions they had had in mind they can now answer. If some questions or material covered by the film cannot be answered, it might be advisable to show the film again. During the second showing, pupils can check the answers which they already have for some of the questions, and find answers to the questions they were unable to answer after the first showing.

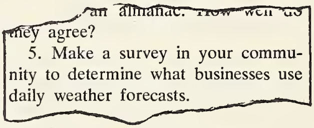
Some films are especially suitable for use as a summary activity. These films are planned and presented to emphasize certain generalizations. The film *Body Defenses Against Disease* is one that could be used to summarize ideas related to the several ways in which the body is protected from diseases. If such a film were used for this purpose, it would be shown after the class had studied this problem in the text. The pupils should be prepared for observing the film by being told that the film emphasizes three important ways in which the body is protected from diseases. They should then be instructed to watch the film carefully with this in mind. After the film is shown, they might be asked to write three sentences stating the three ways in which the body is protected from disease.

In co-operation with Teaching Films Custodian, a committee of the National Science Teachers Association has prepared excerpts of a number of selected Hollywood films. These excerpts for the most part have been prepared to point up important discussion questions related to such topics as: the nature of science, how the methods of science have been used in certain great discoveries, and the effects of technological development on the lives of people. *The First Atomic Pile* is an excellent one to introduce questions regarding the moral responsibility of scientists. *Rainbow of Stone* dramatizes the role of folk lore, or what some might call superstition, in the lives of the Navajo Indian.

Surveys as Learning Experiences

At the end of most units in *The New Basic Science,* pupils are encouraged to conduct one or more surveys to obtain information related to problems in the unit. This is a common method of obtaining information about such questions as "What superstitions have our parents encountered in their relations with other people? What kinds of meals do pupils select at noon in the cafeteria? Is illumination in the classrooms of our school adequate? What accident hazards exist in our community?"

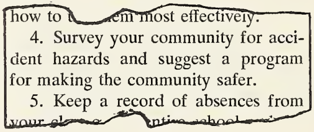
These valuable experiences teach pupils how to plan a course of action and use a specialist.



an almanac.
they agree?

5. Make a survey in your community to determine what businesses use daily weather forecasts.

(p. 304)



how to most effectively.

4. Survey your community for accident hazards and suggest a program for making the community safer.

5. Keep a record of absences from

(p. 475)

Surveys must be carefully planned if they are to be properly conducted. In planning a survey, teacher and pupils should consider the following questions:

1. What kinds of information do we want to get from the survey?
2. How will the information be obtained?
3. Do we need preliminary practice in using the method by which we will obtain the information?
4. How will the information be recorded?
5. Do special forms for recording the information have to be prepared?
6. What arrangements must be made with other persons who may be involved in the method we use for getting the information?

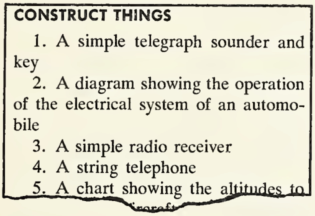
7. If obtaining the information takes us away from school, how should we conduct ourselves?
8. If several pupils are going to obtain information, how will they combine it for purposes of a report?
9. Where and how will the results of our survey be reported?

In planning for certain types of surveys, the teacher and pupils may find it desirable to call in someone to assist them. Suppose that it is decided to survey sanitary conditions in the community. It would be most helpful to have a representative from the Department of Health assist with the planning. He would know what aspects of community sanitation young people could survey and how they could obtain such information through a survey. Furthermore, bringing in such a representative helps pupils learn how to use the specialist.

Construction Projects as Learning Experiences

Construction projects of various kinds are suggested as desirable learning activities in many of the units in *The New Basic Science*. These include building models, preparing bulletin-board displays, preparing posters, drawing diagrams, and making equipment for demonstrations. It is quite important to encourage these creative types of activity for all pupils. Building something may be the only way in which some pupils can be reached effectively. It would be highly desirable to provide facilities for this kind of activity in the science classroom. If it cannot be done, the school art studio, the school shop, or even the home might be used. Encourage pupils to suggest things they can make that are related to the problem upon which they are working.

(p574)



CONSTRUCT THINGS

1. A simple telegraph sounder and key
2. A diagram showing the operation of the electrical system of an automobile
3. A simple radio receiver
4. A string telephone
5. A chart showing the altitudes to

Valuable activity to get all levels of pupils actively participating.

Visits or Trips as Learning Experiences

Throughout *The New Basic Science,* suggestions are made for pupils to visit places to obtain additional information regarding some aspect of the unit they are studying. These visits or trips may be made by one individual, by a small group, or by an entire class, depending upon the purpose. For example, on page 138 of *The New Basic Science,* a visit to a planetarium to observe one of the demonstrations is suggested. If there is a planetarium or possibly an observatory near enough to visit, arrangements should be made for the entire class to attend. What pupils will see at either of these places, they cannot share effectively with those who may not have gone on the trip. The same may also be true of the trips suggested on page 223 of the text. There are other kinds of visits or trips which an individual pupil or a small group of pupils can make, reporting to the class the information obtained if it is something of value to the entire class. Such may be the case for the proposed trip (page 357 of *The New Basic Science*) to the food market to see what measures are taken to keep the food sanitary. Food markets can generally accommodate a limited number of people. Furthermore, the information being sought is of such a nature that one person or a group of three or four can get the information with less inconvenience to the owner of the market than would be the case with a class of 30 pupils. Information of this type can be reported to the class with less loss of learning value than information about the visit to the planetarium. Whenever a trip is being conducted merely to obtain information, the advisability of taking the entire class should be considered. On the other hand, whenever a trip is planned to realize learnings beyond the mere collection of a few facts, it might be desirable to take the entire class.

Visits, either as individual or class activities, give practice in planning and reporting.

MAKE VISITS

1. A telephone exchange
2. A radio broadcasting station
3. An airport
4. A telegraph station
5. A railway station (the dispatcher)
6. A television broadcasting station

(p.574)

If you intend to follow any of the suggestions for visits or trips given in *The New Basic Science,* some careful planning should precede the trip. First, determine whether the places suggested for the pupils' visit are available in the community. The classified telephone directory may be a helpful source of such information. If such places are available, you or some member of the class should get in touch with the persons in charge of them to make necessary arrangements for the visit. This might be done by letter, by telephone, or by actually calling on the person. Such questions as the following should be considered in the preliminary planning with the persons in charge of places to be visited:

1. How does this activity relate to the general policy of the school regarding co-operation of the community in the education of young people?
2. What, specifically, are the purposes of the proposed visit?
3. What can be seen or who can be interviewed at the place under consideration in order to realize the purpose of the visit?
4. In what way should pupils be prepared for this visit?
5. How many can be accommodated?
6. How much time must be allowed for the visit?
7. At what time will the group arrive at the place to be visited?

As was pointed out, the work involved in making arrangements for the visit should, if at all possible, include some pupils. One pupil or a committee of pupils, working with the teacher, could survey the community for possible places to visit, write the letters, make the telephone calls, or call upon persons in charge of places to be visited. Such experiences result in desirable learnings.

Preparation of the class for the visit should include:

1. Plans for obtaining permission of parents, if necessary.
2. Instructions regarding place and time of departure, mode of transportation, provision for lunches if necessary, and time of return.
3. Briefing on the general purpose of the trip and the specific things they are to look and listen for.
4. Discussion of how each person should conduct himself on the trip.
5. Plans for recording the information obtained or their reactions to it.
6. Provisions for summarizing and evaluating the trip.
7. Decision on how to express their appreciation to those who made the trip possible.

If pupils are to make trips as individuals or in small groups, with or without the teacher, much the same procedure would be appropriate. If a report is to be made to the class, it would be desirable for the teacher to assist the pupils in planning it. More attention will be given to making reports as a learning experience in the following section.

Reports as Learning Experiences

In practically every unit of *The New Basic Science,* it is suggested that pupils make reports on topics or questions related to the unit. It is not recommended that reports be given on all these topics nor that the subjects of the reports be limited to the topics listed. These suggested reports not only bring to the class information in addition to that obtained from the text; they also help to bring about certain pupil learnings for which no provision might otherwise be made. Too often, reports are assigned to pupils merely to keep them busy. Under these conditions pupils accept the assignments as routine busy work, and the learnings achieved are generally of a negative type. Pupil reports can be meaningful learning experiences if the teacher makes adequate plans to exploit the learning possibilities of such an activity.

Growth in the following skills can be realized from pupil reports, either oral or written, when they are properly conducted:

1. Locating and using source materials such as books, encyclopedias, periodicals, pamphlets, and newspapers.
2. Taking notes on material read or observations made.
3. Outlining material to be reported.
4. Summarizing.
5. Speaking or writing from prepared notes.
6. Discussing questions raised by the report.

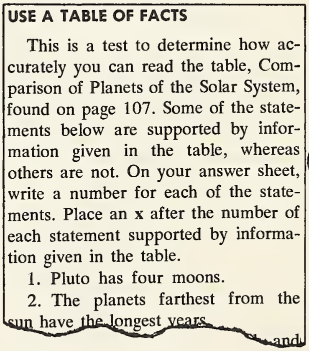
No one would question the value of these skills as learning outcomes, but if pupils are to get practice in them through preparing and making reports, you must make definite plans for teaching them. Before you assign pupils the task of making reports, take class time to help them learn how and where reference materials can be located. If necessary, give lessons on using an encyclopedia and the *Readers' Guide to Periodical Literature* or other such aids to locating information. Lessons should also be taught on how to locate the important ideas in what is read and to record them in note form. In a similar manner, pupils must have instruction, involving guided practice, in outlining, summarizing, and speaking or writing from prepared notes. When you make conscious efforts to use reports as a means of developing these skills, pupil reports have significant educational value. It should also be pointed out that results of surveys, experiments, and visits may often form the bases of individual or group reports to the class. The same careful planning for their presentation is recommended as educationally desirable.

Other Learning Experiences in *The New Basic Science*

Although space does not permit a detailed discussion of each, there are a number of other learning experiences suggested in *The New Basic Science.* Included among these are conducting interviews; interpreting graphic, tabular, and diagrammatic material; making comparisons; solving mathematical problems; and conducting panel discussions. Before pupils go out of the school to conduct interviews, they should have some instruction and practice in interviewing. They should be taught how to arrange for an interview, introduce themselves, ask questions and wait for answers, and acknowledge the co-operation received from the person interviewed.

Graphs, tables, and diagrams appear throughout the book as illustrations.

Unit-end activities such as this give the pupil practice in interpreting the illustrative material.



USE A TABLE OF FACTS

This is a test to determine how accurately you can read the table, Comparison of Planets of the Solar System, found on page 107. Some of the statements below are supported by information given in the table, whereas others are not. On your answer sheet, write a number for each of the statements. Place an **x** after the number of each statement supported by information given in the table.

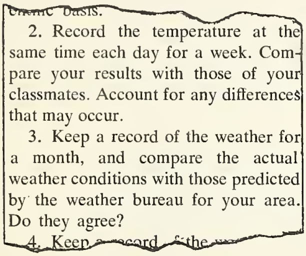
1. Pluto has four moons.
2. The planets farthest from the sun have the longest years.

and

(p. 118)

In order to be sure that pupils are making the proper interpretations of these illustrations, an occasional check on them would be desirable. For example, the graphs on page 15 have no caption, since the authors assumed that these graphs tell their own story. You could test this assumption by asking the pupils to observe the graphs and then write the one important idea which the data in them support. Then ask the pupils more specific questions regarding the meaning of lines and numerals on the graphs.

Wherever it is suggested that pupils make comparisons, do not overlook the possibility of using the activity to help pupils improve their ability to construct tables and graphs as two effective means of comparing quantitative data or qualitative processes. For example,



basis.

2. Record the temperature at the same time each day for a week. Compare your results with those of your classmates. Account for any differences that may occur.

3. Keep a record of the weather for a month, and compare the actual weather conditions with those predicted by the weather bureau for your area. Do they agree?

4. Keep a record of the

On p. 304 are these activities. A table might be an effective way to make the comparison.

In a number of places throughout *The New Basic Science,* pupils are asked to carry on activities involving arithmetical computations. When pupils have difficulty with such computations, the nature of their difficulty should be determined, and some steps taken to help them overcome it.

Panel discussions provide for certain types of experiences that are quite important for young people to have. If you have had no experience in such an activity, seek help from the English or social studies teacher in your school.

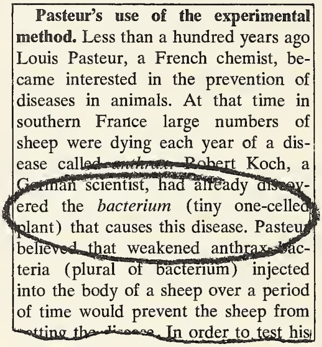
Evaluation as a Learning Experience

The self-tests included in *The New Basic Science* have been prepared to give both pupil and teacher some evidence of pupil growth in an understanding of the science vocabulary used in the book, in an understanding of generalizations developed in the book, in scientific attitudes, and in ability to use the methods of science.

Verbalism in science courses is not uncommon, and every effort should be made to overcome it. The problem-end tests have been designed to give evidence of the extent to which the scientific terms used in each problem are meaningful to the pupils. Teachers should also check pupils occasionally in their discussions to find out what meaning, if any, the words that a pupil is using have for him. Avoid asking pupils to define words; rather ask them what the word means to them. By overemphasizing pupil definitions of words, you may encourage the pupil to memorize statements from the text which have little, if any, meaning for him. Often the words that have no meaning to pupils are non-science words. An example will help make this clear. After studying a section in their text in which the statement was made that "water tends to rise to the same level in communicating vessels," boys were asked to underline "communicating" and "vessels," and then to read the sentence again. After this, they were asked to close their books and write what each of these words meant to them as it was used in this sentence. To several of the boys, "communicating" meant "talking with each other," and "vessels" meant "ships." To these boys, the statement meant that water tends to rise to the same level in ships that are talking with each other.

The authors have made a diligent effort to prevent any such thing from happening to pupils who use *The New Basic Science* as a text. As was pointed out earlier, whenever a new word appears for the first time, it is defined in more familiar words that give meaning to the way it is used in that sentence. It is recommended, though, that teachers check occasionally to see that this technique is effective for all pupils. For example, on page 9 of the text *bacterium* is described as a "tiny one-celled plant."

What do "tiny" and "one-celled" and "plant" mean to your pupils? Only your pupils can answer—and it's important for you to know!



Pasteur's use of the experimental method. Less than a hundred years ago Louis Pasteur, a French chemist, became interested in the prevention of diseases in animals. At that time in southern France large numbers of sheep were dying each year of a disease called anthrax. Robert Koch, a German scientist, had already discovered the *bacterium* (tiny one-celled plant) that causes this disease. Pasteur believed that weakened anthrax bacteria (plural of bacterium) injected into the body of a sheep over a period of time would prevent the sheep from getting the disease. In order to test his

(p. 9)

The importance of discussing test items in *The New Basic Science* after pupils have written and checked their answers has been pointed out in an earlier part of this manual. Through these discussions you can frequently get insight into the meanings that pupils associate with words and ways in which they reasoned to arrive at certain answers. Although neither of these two types of evidence may be revealed by the manner in which they checked the test items, both are extremely important in an evaluation of their learning in science.

A Proposed Outline for Teaching a Unit in *The New Basic Science*

So far we have considered the purposes of *The New Basic Science,* its organization, and the nature of some of the learning experiences proposed in it. Considerable space in this manual has been given to a description of ways in which young people might be introduced to the book. This approach was used not only to suggest techniques for the teacher, but also better to acquaint him with the educative features of the text.

It would probably be helpful to summarize the ideas about the use of *The New*

Basic Science by presenting the following proposed outline for teaching one of its units.

1. Introduce the unit by
    a. Reading unit and appropriate chapter introductions in text
    b. Observing visual materials
    c. Collecting related clippings from periodicals and daily press
    d. Recalling related experiences
    e. Discussing the local significance of the unit and relating it to units previously studied
    f. Examining problem statements in the text and seeing their relation to the unit
2. Study each of the problems in the unit by
    a. Examining headings and subheadings for an overview of the problem
    b. Reading the text
    c. Examining the illustrations
    d. Relating the problem to the local situation wherever appropriate
    e. Performing the observations, demonstrations, or experiments, and relating findings or conclusions to the problem
    f. Carrying out any of the unit-end activities that may be specially related to this problem
    g. Reading the summary and relating it to textual material or formulating summary statements—either as an individual or class exercise
    h. Taking self-test, discussing results, and reviewing concepts where needed
3. Review the problems related to each chapter by
    a. Writing a chapter summary based upon the problem summaries of the chapter—either as an individual or a class exercise
    b. Taking the chapter-end tests and discussing results
    c. Reviewing generalizations where chapter-end tests reveal inadequate understanding
4. Review all problems related to the unit by
    a. Writing a unit summary based upon chapter summaries in 3 above—either as an individual or class exercise
    b. Performing appropriate suggested unit-end activities which have not been previously carried out
    c. Taking the unit-end tests and discussing results
    d. Reviewing generalizations which unit-end tests reveal are not well understood
    e. Practicing additional problem-solving activities where tests on scientific thinking reveal a need.

The Teacher and *The New Basic Science*

Its organization, the manner in which it is written, its illustrations, its self-tests, and the activities included in it make *The New Basic Science* a complete learning guide in general science. But no textbook can replace the teacher as the most important single factor in a successful science course. In the earlier sections of this manual are suggestions for some ways in which teachers might use the book successfully. Because of space limitations, other suggestions that might prove equally valuable were not included. No teacher should consider himself limited to the suggestions given here. There are undoubtedly many other tested techniques which experienced teachers have found to be effective in helping young people to understand science, to use the scientific attitude, and to increase their abilities to use the methods of science. These tested techniques should not be laid aside, if the teacher is sure they are more effective than those set forth in this manual.

The Workbook

As was previously stated, *The New Basic Science* is a complete learning guide in that it provides for pupil experience with the various types of learnings considered desirable in general science. But any textbook has limitations in terms of the amount of subject matter than can be covered as well as of the numbers and types of suggested activities for pupils that can be included. Teachers generally find it desirable to supplement the textbook they use with additional activities. To aid teachers who desire supplementary activities, a pupil's workbook for *The New Basic Science* has been prepared.

The workbook for *The New Basic Science* contains a large variety of activities to help pupils get more meaning from the material in their text and to extend their learning beyond the confines of their text. The activities have been planned to provide experience in desirable learning skills concomitantly with better understanding of scientific concepts.

Pupil activities in the workbook are organized around the same problems that appear in the text. For some problems, the teacher may want to use the workbook for desk work only, although for other problems he may want to provide more active experiences. The activities for each problem, therefore, are arranged in two groups: one group the pupils can do at their desks; the other group they must carry on away from their desks. The activities to be done at the pupil's desk are planned to clinch the basic concepts developed in the text. For the most part, the activities which take the pupil away from his desk are planned to extend his understanding beyond the concepts developed in the text.

FILMS

It is strongly recommended that the guide which is available for most films be obtained (it is free) and studied before the film is used. The letters preceding the names and addresses of film sources are code letters used in the film listing that follows to identify the source. This is not a complete listing. Rather it is representative of the variety of films available.

Film Sources

Alm F Almanac Films, Inc., 516 Fifth Ave., New York 18, N. Y.

Assn F	Association Films, Inc. Headquarters at 347 Madison Ave., New York 17, N. Y. Branch libraries at: Broad at Elm, Ridgefield, N. J.; 79 E. Adams St., Chicago 3, Ill.; 351 Turk St., San Francisco 3, Calif.; 1108 Jackson St., Dallas 2, Texas
Can NFB	National Film Board of Canada, 1270 Ave. of Americas, New York 20, N. Y.
CAA	Civil Aeronautics Administration. Address requests to: Assistant to Regional Administrator of nearest CAA office. Offices at Atlanta, Ft. Worth, Kansas City, Los Angeles, New York, Park Ridge (Ill.), Seattle, Washington, D. C., Anchorage, Alaska, and Honolulu, Hawaii
Coronet	Coronet Instructional Films, 65 East South Water Street, Chicago 1, Ill.; 207 East 37th Street, New York 16, N. Y.
EBF	Encyclopaedia Britannica Films, Wilmette, Illinois
FN	Films of Nations Distributors, Inc., 62 W. 45th St., New York 36, N. Y.
FTRC	Federal Telephone and Radio Co., 100 Kingsland Road, Clifton, N. J.
FMCo	Ford Motor Co., Film Library, 3000 Schaefer Road, Dearborn, Mich.
GE	General Electric Company, Distribution Section, Advertising and Sales Promotion Division, Schenectady 5, N. Y.
Ind U	Indiana University, Audio-Visual Center, Bloomington, Ind.
ISO	International Screen Organization, 609 Philadelphia Ave., Washington 12, D. C.
MBI	Moody Bible Institute, 820 N LaSalle St., Chicago 10, Ill.
McGraw	McGraw-Hill Book Co., Text-Film Department, 330 West 42nd Street, New York 15, N. Y.
Modern	Modern Talking Picture Service, Inc., 45 Rockefeller Plaza, New York 19, N. Y.
MTP	Modern Talking Picture Service, Inc., 45 Rockefeller Plaza, New York 30, N. Y.
PFC	Pictura Films Corporation, 55 Tarrytown Road, White Plains, N. Y.
RmC	Raytheon Manufacturing Co., Public Relations Dept., Waltham 54, Mass.
TFC	Teaching Films Custodian, Inc., 25 West 43rd Street, New York 18, N. Y.
USPBS	United States Public Health Service, Washington 25, D. C.
UW	United World Films, Inc., 1445 Park Avenue, New York 29, N. Y.
YA	Young America Films, Inc., 18 East 41st Street, New York 17, N. Y.

The following directories list and give evaluations of films and can be used to find the latest films on any given subject.

Educational Film Guide, H. W. Wilson Company, 950 University Avenue, New York 52, N. Y.

Educators' Guide to Free Films, Educators' Progress Service, Randolph, Wis.

Directory of United States Government Films, United States Film Service, Federal Security Agency, Washington 25, D. C.

1001 Blue Book of Non-Theatrical Films, Educational Screen, 64 East Lake Drive, Chicago, Ill.

Sources of Visual Aids for Instruction in the Schools, Pamphlet No. 80, United States Office of Education, Federal Security Agency, Washington 25, D. C.

Film Titles

The sources given in this list of films have been indicated by letter symbols. The name and address of the source to which these symbols refer can be found on pages 41–42 of this manual.

Unit 1

Magic Bullets 30 min. sd. USPBS
Story of the development of a drug to cure a disease.
Science and Superstition 10 min. sd. color Coronet 1947
Shows application of scientific methods to the solution of some everyday problems.
Scientific Methods 12 min. sd. B&W and color 12 min. EBF 1954
Technique and thinking of the scientist is illustrated by tracing the discovery of penicillin by Sir Alexander Fleming.
The Story of Louis Pasteur 17 min. sd. TFC
Dramatizes the struggle of Louis Pasteur in developing a serum treatment for anthrax.

Unit 2

Air All Around Us 10 min. sd. YA 1948
Classroom demonstrations of characteristics of air and how it is put to work.
Air in Action 10 min sd. color Coronet 1947
The fundamentals of aerodynamics, and illustrations of Bernoulli's principle.
The Earth's Skin 10 min. sd. AlmF 1952
A look at the earth's crust and the changes which it is undergoing.
Individual Sewage Disposal Systems 42 min. sd. UW-Gov't 1952
Three films dealing with principles underlying septic tanks and their location and construction.
It's in the Air 22 min. sd. color Modern 1954
Shows how air-conditioning equipment improves the air we breathe.
Introduction to Chemistry 10 min. sd. color Coronet 1949
A definition of chemistry together with some of the more important terms.
Making of the River 12 min. sd. Coronet 1954
The life of a river from its source to the sea.
Man's Problem 19 min. sd. color EBF 1953
The story of man's efforts to provide a safe water supply.
Nature's Plan 14 min. sd. color EBF 1953
Illustrates the principles underlying the water cycle and its importance to living things.
Time and Terrain 10 min. sd. color Can NFB 1949
A recreation of the geological processes responsible for the varied terrain of Canada.

Unit 3

Global Air Routes 16 min. sd. Can NFB 1944
Although somewhat old, one of the best treatments of the map as modified by the air age.
How Many Stars 11 min. sd. color MBI 1954
Shows how the new telescopes are used in exploring the universe.

The Infinite Universe 10 min. sd. Alm F 1951

An attempt to reduce the vastness of space to concepts everyone can understand.

New Frontiers in Space 27 min. sd. McGraw 1953

Emphasizes today's research in astronomy.

Solar System 10 min. sd. ISO 1953

The planets of the solar system—many good astronomical photographs.

Unit 4

Electronics in Action 20 min. sd. color RmC 1953

Describes many facets of electronics industry such as radar, computors, guided missiles, etc.

Light All About Us 11 min. sd. color Coronet 1954

Reflection, refraction, and illumination presented from an observational and experimental point of view.

Loran, Part 2 12 min. sd. CAA 1946

An explanation of the principles underlying the Loran system, as well as presentation of the effects of the ionosphere on radio transmission.

Magnetism 10 min. sd. color Coronet 1947

Contrasts magnetism with electricity showing magnets, their theory of operation and many uses.

Moving X-rays 11 min. sd. Alm F 1950

The use of X-rays to see many actions taking place inside the body.

Van Meegeren's Faked Vermeers 27 min. sd. FN 1952

How scientific methods were used to prove Van Meegeren's claim that he painted works of art that had been accepted as work by the artist Vermeer.

Unit 5

Amperes, Volts, and Ohms 8 min. sd. UW 1945

The interrelationship of the fundamental units and how they can be measured.

Measurement of *Electricity* 10 min. sd. Coronet 1949

In a dream sequence, the four scientists whose names have been adopted as the four basic units of electrical measure explain the volt, ampere, ohm, and watt.

Electricity 10 min. sd. color Can NFB 1947

A boy and his friends trace electricity from his home to the hydroelectric plant that generates it.

Series and Parallel Circuits 11 min. sd. EBF 1944

The relationship between resistance, current, and voltage in both series and parallel circuits.

Unit 6

Fire 10 min. sd. EBF 1947

Emphasizes the essentials of combustion, showing major home fire hazards and methods of extinguishing fires.

Ingredient "X" 23 min. sd. color GE 1947

Traces the use of heat in cooking from prehistoric to present times.

Measuring Temperature 11 min. sd. YA 1951

An exposition of the principles underlying the construction of various types of thermometers.

Nature of Heat 10 min. sd. color Coronet 1953

Heat presented as molecular motion, together with questions designed to promote discussion and experimentation.

Transfer of Heat 11 min. sd. YA 1949

Presentation of the principles underlying heat transfer by conduction, convection, and radiation.

Unit 7

Clouds 10 min. sd. AlmF 1951

The formation of clouds and their relation to weather is investigated through time-lapse photography.

Great Winds 10 min. sd. UW 1951

The general circulation of air and the forces that cause it.

Weather and Radar 17 min. sd. UW 1953

How weather scientists use radar in their work.

Aerology: Part 1, *Formation and Structure of Thunderstorms* 17 min. sd. UW 1953

Explains how thunderstorms are formed.

Part 2. *Flight Techniques with Respect to Thunderstorms* 15 min. sd. UW 1953

Explains best ways to fly in and through thunderstorms.

Unit 8

Alcohol and Tobacco: What They do to Our Bodies 11 min. sd. color Coronet 1953

An exposition of the effects of the use of alcohol and tobacco on the body, together with the ways these effects are evident to the user.

Behind the Menu 10 min. sd. Can NFB 1950

An analysis of possible unsanitary conditions in restaurants, with suggestions for their removal.

Body Defenses Against Disease 11 min. sd. McGraw 1947

Describes both the external and internal body defenses against disease, and the way in which man aids the body in using these defenses more effectively.

Drug Addiction 22 min. sd. EBF 1952

Emphasizes the hazards in the use of narcotic drugs as well as the physiological effects underlying effects produced by using drugs.

Preserving Food 10 min. sd. color Coronet 1949

Methods of long and short term food preservation are discussed together with reasons underlying each method.

Tobacco and the Human Body 15 min. sd. EBF 1954

Presents the scientific facts, as they appear today, on the effects of nicotine and various tars found in tobacco smoke on the human body. Takes no side in argument for or against smoking.

Your Food 12 min. sd. YA 1953

The nature and function of basic food elements.

Unit 9

Asexual Reproduction 10 min. sd. color Ind U 1954

Shows the differences between asexual and sexual reproduction with respect to variability of offspring.

Bacteria—Friend or Foe 11 min. sd. color EBF 1954

Shows four main types of bacteria and conditions favorable for their life. Some historical treatment included.

Chain of Life 11 min. sd. color PFC 1953

Examples of natural food chains which tie together the living creatures in a community.

Characteristics of Plants and Animals 10 min. sd. color Ind U 1954

A basic film showing the characteristics common to living things—movement, response to stimuli, reproduction, growth, and obtaining energy.

Development of the Chick Embryo 5½ min. sd. color Coronet 1953

The chick development shown by use of both drawings and photographs.

Insects 10 min. sd. color EBF 1953

Illustrates characteristics of five insect groups and shows how man controls insects to suit his purposes.

Introducing the Reptiles 17 min. sd. color McGraw 1954

The methods of eating, reproduction, and the habitat of five kinds of reptiles.

Sow and Sow 10 min. sd. Alm F 1952

Good treatment of seed dispersal and plant reproduction.

World of Little Things 15 min. sd. color MBI 1954

Shows how microscopic plants and animals live together in water and the delicate balance of life they establish.

Unit 10

The Beaver Makes a Comeback 16 min. sd. color Can NFB 1953

Contrasts the economic life of an Indian population when the beaver had almost been exterminated with the improved conditions after stocking the area.

Breaking the Web 11 min. sd. color PFC 1953

Shows the disastrous effects of injudicious development and mismanagement of land on the wildlife of this country.

Meaning of Conservation 11 min. sd. color Coronet 1954

A history of our use of natural resources and some of the reasons for conservation.

The River 32 min. sd. CFD 1937

A documentary film which dramatizes the effects of misuse of farm and forest lands.

A Strand Breaks 15 min. sd. color EBF 1950

Shows how a natural community can be destroyed when one element gets out of hand, thus setting up an imbalance in nature.

Water for the Prairies 19 min. sd. color Can NFB 1951

Points out the relationship of forest conservation to abundant water for irrigation and power use.

Water on the Fire 27 min. sd. color UW 1953

Shows economical and effective ways of using water to extinguish fires in forests of Eastern United States.

Unit 11

Atom and Biological Science 12 min. sd. EBF 1953
A presentation of some of the biological effects of radiation. It also shows how experiments with "hot" materials are conducted.

Atom Goes to Sea 12 min. sd. GE 1954
Explains the operation of an atomic-powered submarine within the limits of military security.

Radio-isotopes in Agricultural Research 41 min. sd. UW 1953
Shows the role of radio-isotopes in research on the utilization of chemicals by plants and animals.

Unit 12

Helicopters 11 min. sd. EBF 1954
An exposition of the principles of helicopter flight, together with a survey of the uses and potentialities of helicopters.

Modern Communications with Microwave 20 min. sd. color FTRC. 1954
A broad coverage of the many types of two-way communication systems utilizing microwaves.

Vital Link 10 min. sd. Assn F 1954
Explains the importance of a television antenna and shows how research and testing of antennas is carried on.

Age of Flight 18 min. sd. McGraw.1953
Shows the importance of radio beams, flashing beacons, and modern weather stations to safe flight.

American Road 43 min. sd. FMCo 1953
The story of the way the development of the automobile has influenced American life over the years.

Building a Highway 11 min. sd. EBF 1948
All the major construction steps in building a modern two-way highway are shown.

Science in the Orchestra 35 min. sd. McGraw 1952
A series of three films depicting the nature of sound, how musical instruments produce sound and why each instrument has its own "voice."

Shining Rails 20 min. sd. color GE 1951
The evolution of locomotive power from steam to gas turbine electric.

Unit 13

Research for Better Living 17 min. sd. color UW 1953
Shows how various agencies help in assuring quality in various products.

Science and Wood Utilization 6 min. sd. color Coronet
The part research plays in the utilization of wood for a variety of uses.

Winning Seals of Approval 20 min. sd. color MTP
Shows laboratory testing of gas ranges.

MATERIALS AND SOURCES

You will note that although these lists seem extensive, they consist mostly of things that are easily available and inexpensive.

List of Materials (Supplies) Needed to Perform Observations, Demonstrations, and Experiments in *The New Basic Science*

Description	*Unit in Which Used*
Acid, carbolic, 2%	9
Acid, nitric	8
Agar, nutrient	8
Alcohol	2, 9
Ammonium hydroxide	8
Ball, rubber	3
Ball, ping pong	3
Balloon, rubber	3, 7
Barrel or box or lard can, 3x3x3 feet	9
Beans, dry	8
Benedict's solution	8
Bichloride of mercury, .1%	9
Block, wood, iron, cork, and pad of felt, sponge rubber, all of same thickness	12
Block, wood, 2x4x6 inches	12
Boards, wood, 2x4x6 inches, 1x4x42 inches, ½x½x20 inches, 1x4x14 inches, ½x½x24 inches	7, 11, 12
Box, 2x4x6 inches	9
Box, cardboard	7
Bread	9
Brick	12
Broomstick	7
Butter	8
Cardboard sheet, 8½x11 inches	4
Cardboard sheets, 5x6 inches, 3x3 inches	3, 7
Cardboard square, 2x2 inches	2
Carrot	9
Charcoal, powder	13
Clips, paper	3, 9
Cloth, cheese 6 inch square	9
Cloth, cotton, 1x4 inches; 1 square yard	7
Cloth, small pieces, black, white, red, orange, blue, green	6
Coal, soft, several small pieces	10
Coloring, food, green and yellow	2, 9
Copper oxide	13
Cornstarch	8
Cord, 22 feet	3
Cord, sash, 2 feet long	12
Cotton	8

Description	*Unit in Which Used*
Cups, paper	7
Detergent, synthetic	2
Dime, coin	2, 4
Egg white	8
Eggs	9
Elodea or eel-grass plant	9
Ether	6
Fehling's Solution A and B	8
Fertilizer, commercial	9
Fly, fruit (see page 424, *The New Basic Science,* for sources)	9
Fork, table	9
Fur, about 1 square ft.	4
Geranium plant, potted	9
Gizzard, chicken	9
Grass sod, with dandelions	9
Growth-regulator	9
Hangers, clothes	7
Ice	7
Ink, red	3
Iodine, tincture	8, 9
Iron filings	2, 4
Kerosene	2
Leaves, plant	2
Lime water	9
Mailing tube, 2 inches diameter, 2 feet long	3
Mercury	7
Nail, large or spike	5, 7
Nail, small	6, 11
Paper, black	3, 9
Paper, blotting	9
Paper, ruled (one sheet)	3
Paper, sand (one sheet each of several sizes)	11
Paper, strip, 1x12 inches	12
Paper, strip, tissue, ⅛x6 inches	6
Paper, waxed	2
Pencils, round	6, 11, 13
Phenolphthalein Solution	2
Pin, straight common	2, 9
Plaster of Paris	2
Plastic articles such as toothbrush, comb, bottle caps	13
Rocks, small	2, 9
Rubber bands	3, 9
Salt	2
Sand	4, 9
Sausage skin or goldbeater's membrane	8
Seeds, corn	9
Seeds, radish	9

Description	*Unit in Which Used*
Seeds self-pollinated (see page 420, *The New Basic Science*, for sources)	9
Shavings, wood, from pencil sharpener	6
Silk, about 1 square foot	4
Soap, granulated	2
Soil	9, 10
Spool, thread	2
String	2, 3, 11
Sugar, glucose; brown	8
Syrup	9
Tacks, carpet	4
Tape	2, 6, 7
Thread, sewing, several sizes and kinds	4, 12, 13
Tin can	10
Towel, paper	9
Tree, young apple, trunk 1 inch diameter	9
Wax, grafting	9
Weed killer, chemical	9
Wheat, cracked, 2 pounds	9
Wire, copper, bell	4, 5, 6
Wire, copper #28 or # 30	6
Wire, iron	6
Wool, about 1 square foot	4

List of Equipment Needed to Perform Observations, Demonstrations, and Experiments in *The New Basic Science*

Quantity	*Description*	*Unit in Which Used*
3	Air thermometer tubes	3
1	Anvil or vise	6
1	Aquarium	11
1	Baking dish, glass	2, 9
1	Balance, trip	2, 9
4	Balls, pith	4
3	Beaker, 250 ml	2, 3, 6, 7, 9, 13
1	Beaker, 500 ml	2, 7, 13
1	Bird feeding station (see page 406, *The New Basic Science*)	9
1	Borer, cork	9
1	Bunsen burner	2, 6, 7, 8, 9, 13
4	Bottles, wide-mouthed (ink)	3, 7, 8, 9
1	Camera	3
1	Can, overflow	2
1	Candle	3, 7
2	Cell, dry	4, 5
1	Clamp, adjustable for meter stick support	11

Quantity	*Description*	*Unit in Which Used*
2	Clamp, burette	2, 3, 6, 7, 13
2	Compass	4
1	Cord, extension	3
37	Cork, rubber, size 0	11
2	Cup, polished metal	7
1	Cylinder, graduated	2, 7
1	Dish, flat-bottomed	4
6	Dish, petri	8
1	Dropper, medicine	8
1	Flask, florence type, glass, 250 ml.	2, 6, 7
8	Flowerpots, large	9, 10
4	Flowerpots, small	9, 10
1	Fork, tuning, low-frequency	12
2	Funnel, glass, 60 mm.	9
1	Galvanometer	5
1	Glass, magnifying (hand lens; convex)	3, 4, 9
6 pair	Glasses, ordinary sun	4
1	Globe, earth	3
1	Hammer	6
1	Holder, test tube	8
1	Hot plate, electric	9
1	Induction coil	4
1	Incubator (see page 377, *The New Basic Science*)	9
2	Jars, battery	9
4	Jars, quart or half gallon	10
1	Lamp, heat	3
1	Lantern, slide, with one slide	3, 4
2	Magnets, bar	4, 5
1	Magnet, horseshoe	5
1	Meter stick	11, 13
1	Microscope	8
2	Mirror, pocket	3
1	Motor, electric	5
36	Mousetraps, spring type	11
4	Pie tin	2, 7, 9
1	Plate, glass, 4x4 inches	2
1	Pump, tire	6
2	Ringstand, with ring	2, 3, 6, 7, 11, 13
2	Rod, copper, ⅛ diameter x 6 inches	6
1	Rod, glass	4
2	Rod, rubber	4
2	Rod, stirring	7
1	Rod, iron, about ⅛x6 inches	6
1	Rod, wood, about ⅛x6 inches	6
1	Ruler	9
1	Scale, spring, 500 gram	2, 11
1	Scale, spring, 1 kilogram	13

Quantity	*Description*	*Unit in Which Used*
1	Scissors	7
1	Screen, projection	4
1	Screen, wire (gauze), 4x4 inches	2, 6
1	Slide, microscope	9
1	Stopper, 1 hole, to fit 250 ml flask	2, 3, 6, 7, 9
1	Spring, coil	13
2	Switches, knife	4, 5
6	Test tubes	2, 8, 9, 13
5	Thermometer, 110 C or 220 F	6, 7, 8, 9
1	Truck or automobile, toy	11
4 feet	Tubing, glass	2, 3, 6, 7, 10
2 feet	Tubing, rubber	2, 10
1	Watch glass, small	6
1	Watch, stop; or watch with sweep second hand	6, 11
3	Weight, one each 50 g, 100 g and 200 g	6, 11, 13
2	Yard stick	3, 7
1	Thistle tube	8

Scientific Supply Companies

Biological Supply Company, 1176 Mt. Hope Avenue, Rochester, N. Y.
Cambosco Scientific Company, 37 Antwerp Street, Brighton Station, Boston, Massachusetts
Central Scientific Company, 460 East Ohio Street, Chicago, Illinois; 220 East 42nd Street, New York, N. Y.; 1121 S. Hill Street, Los Angeles, California; 79 Amherst Street, Boston, Massachusetts
Chicago Apparatus Company, 1735 North Ashland Avenue, Chicago, Illinois
Fischer Scientific Company, 711 Forbes Street, Pittsburgh, Pennsylvania
General Biological Supply House, Inc. (Turtox), 761–763 East 69th Place, Chicago, Illinois
Michigan Biological Supply House, 206 South First Street, Ann Arbor, Michigan
New York Scientific Supply Company, Inc., 28 West 30th Street, New York, N. Y.
Scientific Supplies Company, 123 Jackson Avenue, Seattle, Washington
Southern Biological Supply Company, 517 Decatur Street, New Orleans, Louisiana
South-Western Biological Supply Corp., Ledbetter Drive, Dallas, Texas
University Apparatus Company, 2229 McGee Avenue, Berkeley, California
W. M. Welch Scientific Company, 1515 Sedgwick Street, Chicago, Illinois
Western Laboratories, 826 Q Street, Lincoln, Nebraska

KEY TO TESTS AND CHAPTER- AND UNIT-END ACTIVITIES

Pages 6–7: Test Yourself

1. a **2.** e **3.** c **4.** c **5.** e **6.** b **7.** a **8.** d

Page 12: Test Yourself

1. a **2.** c **3.** d **4.** d

Page 13: Chapter Activities. Review Your Understanding

1. c **2.** c **3.** curiosity **4.** a,b,a,a,b,b

Page 17: Test Yourself

1. True **2.** False **3.** True **4.** False **5.** False **6.** False

Page 20: Test Yourself

1. False **2.** True **3.** False **4.** False **5.** True **6.** False

Page 21: Chapter Activities. How Scientific Are You?

1. d **2.** c **3.** a,c,e

Pages 21–22: Unit Activities. Use Scientific Methods

1. c: most likely to result in an accurate, satisfying decision.
2. a: not scientific; athlete is not a specialist in health.
   b: scientific; recommended by a specialist in mouth care.
   c: not scientific; friend is not a doctor.
   d: not scientific; courses not selected to forward a worth-while purpose.
   e: not scientific; amount of advertising not a good measure of the value of a camera.
   f: not scientific; advertising may not be true.
   g: scientific; action based upon advice of health specialist.
   h: scientific; may prevent damage to the body.
   i: not scientific; thirteen not an unlucky number.
3. Answers for these will probably vary. This fact should be emphasized in a discussion of the different answers. However, in e, the answer is, of course, "make careful measurement" and use the measurements as a basis for checking a-d.
4. Milk; specific gravity is usually between 1.029 and 1.034 at 15.5° C.; by weighing flasks on scale sensitive enough to show the difference or by looking in an authoritative source such as an encyclopedia.
5. The students' answers will vary. Check by adding water. The beaker that holds most water has greatest amount of air space.

Page 39: Test Yourself

1. b **2.** c **3.** b **4.** c **5.** c **6.** c **7.** c

Page 47: Test Yourself

1. c **2.** c **3.** d **4.** a **5.** d **6.** a

Pages 47–48: Chapter Activities. Review Air and Its Uses

1. a: Gas b: Solid c: Gas d: Solid e: Solid f: Liquid
2. a: Element b: Compoupnd c: Compound d: Element e: Element f: Compound
3. a: $4Fe + 3O_2 \rightarrow 2Fe_2O_3 + Q$ b: $C + O_2 \rightarrow CO_2 + Q$
4. 1: a,d 2: a 3: b,d 4: b 5: a 6: d 7: b,d 8: b,d 9: c,d 10: c,d 11: d 12: b 13: a

Think Through Some Problems

1. Hypothesis: reduced air pressure fails to balance internal blood pressure, thus causing thin blood vessels to burst.
   Facts: normally pressure inside body balances atmospheric pressure; atmospheric pressure decreases with increase of altitude.
2. d
3. Needed to keep pressure inside cabin higher than low pressure outside cabin at high altitudes, thus keeping passengers more comfortable as well as providing sufficient oxygen; prevents situation of problem 1 developing.
4. Pressure applied to the chest and released at regular intervals affects lungs in somewhat the same manner as changes in position of diaphragm and ribs.

Page 59: Test Yourself

1. c **2.** b **3.** a **4.** d **5.** a

Page 64: Test Yourself

1. True **2.** Boiling **3.** Alkali **4.** Potassium Hydroxide **5.** True **6.** Hard **7.** True **8.** True

Pages 69–70: Test Yourself

1. b **2.** c **3.** b **4.** d **5.** c

Page 70: Chapter Activities. Apply Your Understanding

1. a **2.** b **3.** a **4.** b **5.** a **6.** a **7.** b **8.** b

Use the Scientific Method

1. Hypothesis: water from deep well more likely to be hard because it has dissolved chemicals from earth.
2. Method: punch a row of holes in can from top to bottom, fill can with water, and compare horizontal distance of various streams of water issuing from holes in can.

Pages 82–83: Test Yourself

1. c **2.** b **3.** d **4.** d

Page 92: Test Yourself

1. Coal:b Uranium:a Oil:b Salt:b Sulfur:b Iron:a
2. b,d,e,

Page 92: Chapter Activities. Select Hypotheses

1. b

Pages 92–93: Unit Activities. Apply What You Learned

Question	*Sentence*	*Generalization*
1.	3	a
2.	2	d
3.	6	b
4.	4	c
5.	5	b

Plan and Perform Activities

1. Sprinkle powdered alum into a glass of muddy water. Observe results.
2. Treat samples of hard water with equal amounts of washing soda and borax. Compare the amount of soap needed in each of the treated samples.
3. Shift a load from one place to another in the boat.
4. Using same materials, repeat the demonstration on page 69 using salt water instead of fresh water. Compare results.

Page 104: Test Yourself

1. c **2.** b **3.** a **4.** a **5.** c

Page 117: Test Yourself

1. Solar system **2.** True **3.** Planets **4.** Heavier (contains more matter) **5.** True **6.** True

Pages 117–118: Chapter Activities. Review Your Understanding

1. 1:b 2:d 3:a 4:a 5:e 6:c 7:b 8:a 9:b 10:a 11:a 12:b 13:b 14:b 15:a 16:a
2. 1:b,d,e 2:a,b,d,e

Use a Table of Facts

2. x **5.** x

Page 129: Test Yourself

1. Radiant energy **2.** True **3.** Small particles **4.** Antarctic Circle **5.** True **6.** True **7.** True

Page 133: Test Yourself

1. Moon **2.** As much as seven minutes **3.** To study the corona and chromosphere. **4.** Earth between sun and moon **5.** Flood tide is high; ebb tide is low **6.** Gravitational pull of moon and sun **7.** Spring tide; pull of both moon and sun are in same direction: neap tide; pulls of moon and sun are at right angles to each other

Page 136: Test Yourself

1. d **2** a **3.** d **4.** b **5.** b **6.** a

Pages 136–137: Chapter Activities. How Do Distant Bodies Affect Us?

1. b,d **2.** b,d **3.** a,c

Select Reliable Information

b,c,e

Pages 137–138: Unit Activities. Relate Facts to Man's Activities

1. g **2.** a,j **3.** a,c,d,e,k **4.** d **5.** f **6.** g **7.** i **8.** f **9.** h **10.** g,h **11.** f **12.** a,b,d,e,f **13.** c

Page 150: Test Yourself

1. True **2.** True **3.** Repel **4.** Negative **5.** True

Page 157: Test Yourself

1. b **2.** a **3.** c **4.** c **5.** a

Pages 157–158: Chapter Activities. Review Your Understanding

1. b,c **2.** a,c,d

Recognize Assumptions

1. a,b **2.** a,c,d

Page 167: Test Yourself

1. c **2.** a **3.** a **4.** a **5.** c

Pages 169–170: Test Yourself

1. Higher **2.** Produced **3.** The sun **4.** The atmosphere **5.** Total

Page 188: Test Yourself

1. b **2.** c **3.** b **4.** a **5.** c

Page 190: Test Yourself

1. c **2.** b **3.** a **4.** c **5.** c

Page 192: Test Yourself

1. b **2.** b **3.** c **4.** a **5.** a

Pages 192–193: Chapter Activities. Review Your Understanding

1. a

Test a Hypothesis

4

Recognize Assumptions

2

Pages 193–194: Unit Activities. Apply Your Knowledge

1. a:3,2,1 b:1 c:2 d:2 e:1,2

2. a:1 b:1 c:1,2 d:1,3 e:1,3

Increase Your Understanding

1. The fact that electric sparks produce radio waves can be demonstrated by producing electric sparks with an induction coil or an electric motor with brushes; or by discharging a charged rubber rod near the antenna of a radio when the radio is operating with the volume control turned up but not tuned to a radio station.

Page 202: Test Yourself

1. c **2.** b **3.** b **4.** b

Page 208: Test Yourself

1. a **2.** c **3.** b **4.** c **5.** a

Page 208: Chapter Activities. Review Your Understanding

2, 7, 1, 6, 5, 3, 4 or 2, 7, 1, 5, 6, 3, 4

Select Sources of Information

b,c,d

Page 213: Test Yourself

1. a **2.** c **3.** b **4.** b **5.** b

Page 215: Test Yourself

1. True **2.** One **3.** 22

Page 220: Test Yourself

1. b **2.** a **3.** c **4.** c **5.** b

Pages 221–222: Chapter Activities. Review Uses of Electricity

1. Heating **2.** Chemical **3.** Magnetic **4.** Magnetic **5.** Heating **6.** Heating **7.** Heating **8.** Magnetic **9.** Heating **10.** Heating

Solve Mathematical Problems

1. 2 amperes **2.** 115 ohms **3.** 4.5 volts **4.** 1600 watts **5.** 4.8¢ **6.** 72¢

Pages 222–223: Unit Activities. Apply Your Knowledge

1. c **2.** c

Explanations About Electricity

4. One method is to electroplate the shoes with some metal. The shoes are first cleaned and then covered with some material such as graphite so they will conduct electricity. They are then connected to the negative terminal of a source of D.C. electricity and electroplated as described on page 218.

Page 230: Test Yourself

1. d **2.** b **3.** b **4.** c **5.** c

Pages 235–236: Test Yourself

1. c **2.** a **3.** c **4.** c **5.** a

Page 236: Chapter Activities. Recognize Assumptions

2, 3, 5, 7, 9, 10

Page 243: Test Yourself

1. d **2.** c **3.** a **4.** c **5.** b

Page 251: Test Yourself

1. c **2.** a **3.** c **4.** b **5.** c

Page 251: Chapter Activities. Test Your Understanding

1. a,d,f **2.** a,b,e

Pages 255–256: Test Yourself

1. c **2.** d **3.** c **4.** b **5.** c

Pages 258–259: Test Yourself

1. b **2.** c **3.** d **4.** b **5.** c

Pages 260–261: Chapter Activities. How Is Heat Controlled?

1. a,b,e,f **2.** b,d,e,f

Select Hypotheses

1. c **2.** c **3.** c

Pages 261–262: Unit Activities. Apply Your Knowledge of Heat

a. 1 **b.** 2 **c.** 4 **d.** 4 **e.** 1 **f.** 3 **g.** 5 **h.** 5 **i.** 2 **j.** 4 **k.** 3

Page 272: Test Yourself

1. a **2.** b **3.** b **4.** c **5.** c

Pages 275–276: Test Yourself

1. a **2.** c **3.** c **4.** b **5.** c **6.** a

Page 276: Chapter Activities. Weather and Climate

1. w **2.** c **3.** w **4.** c **5.** c **6.** w **7.** c

Make an Outline

General topics: 4 followed by 2,5
1 followed by 3,8
9 followed by 6,7,10

Page 291: Test Yourself

1. a **2.** b **3.** d **4.** c **5.** d

Pages 297–298: Test Yourself

1. b **2.** c **3.** b **4.** c **5.** d **6.** a

Page 301: Test Yourself

1. c **2.** a **3.** c **4.** c **5.** a

Pages 301–303: Chapter Activities. Review Weather and Climate

1. b **2.** c

Interpret a Table

1. X **2.** T **3.** X **4.** X **5.** X **6.** X **7.** X **8.** X

Pages 303–304: Unit Activities. Apply Your Knowledge

1. U **2.** P **3.** U **4.** U **5.** U **6.** M **7.** U

Build Weather Instruments

1. *A simple mercury barometer.* Obtain a board 1x4x42 inches, a glass tube, a meter stick, strips of tin cut from a tin can, and a balloon. Mount the meter stick a little to the right of center on the board. Fasten it near the upper and lower ends by means of a strip of tin stretched over the meter stick and fastened to the board on each side of the stick, but loose enough to allow for raising or lowering the stick several inches.

   Prepare a piece of glass tubing (6 mm. outside diameter and 36 inches long) by completely sealing one end of the tube in a flame. Attach a wide-mouthed ink bottle at the lower end of the board and to the left of the meter stick by means of a strip of tin stretched tightly over the bottle and nailed to the board. Fill the bottle about half full of mercury. Fill the glass tube with mercury, using an eye dropper, and making sure that all air bubbles are out of the mercury. Stretch a piece of thin rubber from a balloon over the open end of the tube, holding it firmly on the sides of the tube so that the mercury will not drop out when you invert the tube.

   Now invert the tube and carefully insert it into the bottle so that no air bubbles get into the tube; remove piece of rubber after tube is in position. If air bubbles should get into the tube of mercury, the process must be repeated. Attach the glass tube to the board, in a position parallel to the meter stick, by strips of tin. Adjust the meter stick so that the bottom of it is level with the surface of the mercury in the bottle. The height of the mercury in the tube is a measure of atmospheric pressure.
2. *A weather vane.* Make an arrow in the following manner. To one end of a piece of wood ½x½x20 inches (the shaft of the arrow) attach a triangular piece of

cardboard to represent the point of the arrow. The base of the triangle should be about 3 inches wide, and should be fastened to the end of the stick so that the point extends about 1 inch beyond the end of the stick. To the other end of the shaft attach a 5x6 inch piece of cardboard and trim the front and back edges to represent the shape of the feather-end of an arrow. Bore a small hole through the shaft of the arrow about 7 inches from the tip. Drive a finishing nail into one end of a broomstick, leaving about 2 inches of the nail extended from the end of the stick. Mount the arrow on the end of the broomstick by passing the nail through the hole in the shaft. This is the completed weather vane. In order to show wind direction, the weather vane should be mounted on the top of some building.

3. *A sling psychrometer.* Obtain a board 1x4x14 inches. Securely attach two thermometers in parallel positions onto the board so that there are about 4 inches between them. The bulb of one thermometer should be about 2 inches below the bulb of the other. Wrap a thin cloth around the bulb of the lower thermometer and tie in place. Bore two holes near the upper end of the board and attach a loop of strong cord to which the operator can hold. Wet the cloth around the thermometer bulb and swing the board much as a baseball pitcher "winds up" before throwing the ball. Swing the board until the temperature readings on the two thermometers are constant. The relative humidity can be computed by using the table on page 289.
4. *A rain gauge.* A simple one can be made by placing a funnel into a flat-bottomed glass cylinder such as a graduated cylinder. In order to determine what depth of water in the cylinder would be equivalent to 1 inch of rainfall, divide the square of the radius of the top of the funnel by the square of the radius of the cylinder. For example: if the radius of the top of the funnel is 3 inches and the radius of the graduate is 1 inch, it will take 9 inches of rain in the graduate to equal 1 inch of actual rainfall. Suppose you collected 1 inch of water in the graduated cylinder during a rain. It would indicate that ⅑ inch of rain had fallen.
5. *A cup anemometer.* Obtain two pieces of wood, ½x½x24 inches. Lay one piece on top of the other so that they form four right angles. The halves of each piece of wood, from the center out, represent the spokes of a wheel, and each spoke should be exactly the same length. Now fasten the two pieces of wood together in this position. Bore a hole, large enough for a nail to pass through, at the center of the pieces of wood in a position corresponding to the center of the wheel. At the end of each spoke attach a shallow paper cup in such a position that the wind will blow into the cup when the wheel is in a horizontal position. Drive a finishing nail into the end of a pole, leaving about 2 inches of the nail sticking out. Mount the wheel in a horizontal position on the pole by passing the end of the nail through the hole in the center of the wheel. In order for the wheel to turn freely when the wind hits the cups, it may be necessary to rub grease or soap on the end of the pole.
6. *A hair hygrometer.* Use a rectangular box about 8 inches long and 4 inches wide, such as a paper milk carton, as the base of the hygrometer. Lay the box lengthwise on a table. On the upper side of the box, near the edge facing you and about 2 inches from one end, attach two upright strips (1 inch by 1 inch) of cardboard about two inches apart. Run a large sewing needle through these upright pieces to form a free turning shaft, with the eye of the needle extending

over the edge of the box. Place one end of a thin broom straw through the eye of the needle and secure it with glue. Allow the other end of the broom straw to extend downward over the edge of the box as a pointer.

Obtain a human hair about 9 inches long that is free from oil. Attach the hair by using tape at the opposite end of the box from the shaft. Stretch the hair the full length of the box, wrapping it once around the needle shaft. To the free end of the hair, attach a weight—such as a penny—and allow it to hang down over the end of the box so that the hair is taut. As the humidity changes, the length of the hair will change and the pointer will move accordingly.

Pages 322–323: Test Yourself

1. a **2.** c **3.** c **4.** d **5.** b **6.** d **7.** b **8.** d

Page 333: Test Yourself

1. c **2.** d **3.** c **4.** d **5.** d

Pages 333–334: Chapter Activities. Review the Human Body

a. 1 **b.** 4 **c.** 5 **d.** 1 **e.** 5 **f.** 5 **g.** 3 **h.** 4 **i.** 3 **j.** 2 **k.** 6
l. 4 **m.** 3,4 **n.** 2 **o.** 4 **p.** 6 **q.** 3 **r.** 2 **s.** 6 **t.** 6

Select Generalizations

Part 1. 5 **Part 2.** 6

Page 340: Test yourself

1. Evil spirits **2.** True **3.** True **4.** Parasite **5.** True

Page 343: Test Yourself

1. a **2.** c **3.** c **4.** d **5.** a

Page 347: Test Yourself

1. b **2.** a **3.** b **4.** d **5.** c

Page 351: Test Yourself

1. Destroy their breeding places **2.** True **3.** True **4.** Isolation or quarantine **5.** True

Page 355: Test Yourself

1. c **2.** c **3.** b **4.** a

Pages 355–356: Chapter Activities. Review the Causes of Disease

a. 1 **b.** 5 **c.** 3 **d.** 2 **e.** 4 **f.** 3 **g.** 3 **h.** 4 **i.** 5 **j.** 3 **k.** 1 **l.** 4 **m.** 5
n. 3 **o.** 2 **p.** 1 **q.** 4 **r.** 3 **s.** 3

Use a Generalization

1. a,b,c,e **2.** a,c,d

Pages 356–357: Unit Activities. Apply Your Knowledge

a. 2 **b.** 2 **c.** 6 **d.** 5 **e.** 3 **f.** 1 **g.** 2 **h.** 3 **i.** 6 **j.** 1 **k.** 3 **l.** 2 **m.** 3
n. 6 **o.** 6 **p.** 6

Page 372: Test Yourself

1. c **2.** c **3.** c **4.** b **5.** c

Page 378: Test Yourself

1. c **2.** d **3.** c **4.** a

Page 378: Chapter Activities. Review Your Understanding

1. b,f **2.** a,h **3.** c,g,i **4.** d

Analyze an Experiment

2,4

Page 387: Test Yourself

1. c **2.** a **3.** c **4.** b **5.** a

Page 392: Test Yourself

1. Loam **2.** True **3.** True **4.** Citrus fruits

Page 396: Test Yourself

1. a **2.** c **3.** d **4.** c

Pages 400–401: Test Yourself

1. Beneficial **2.** Contact poison **3.** Helpful **4.** True **5.** True

Page 401: Chapter Activities. Review How to Care for Plants

a. 1 **b.** 5 **c.** 1 **d.** 6 **e.** 2 **f.** 3 **g.** 4

Can you Think Scientifically?

2,3,4,5,6

Page 407: Test Yourself

1. True **2.** True **3.** Silage **4.** True **5.** Hens

Page 410: Test Yourself

1. True **2.** DDT **3.** True **4.** True

Page 412: Test Yourself

1. Canaries **2.** Light **3.** Gills **4.** True

Pages 412–413: Chapter Activities. Review Animal Care

a. 3 **b.** 2 **c.** 4 **d.** 1 **e.** 3 **f.** 4 **g.** 2 **h.** 3 **i.** 2 **j.** 1 **k.** 1 **l.** 1 **m.** 1

Select Hypotheses

2

Page 421: Test Yourself

1. a **2.** c **3.** c **4.** d

Pages 423–424: Test Yourself

1. d **2.** c **3.** d **4.** c

Pages 425–426: Chapter Activities. Form a Generalization

1. a,d,f **2.** a,c,e

Check Your Understanding

1. I **2.** C **3.** I **4.** C **5.** I **6.** I **7.** I **8.** I

Pages 426–427: Unit Activities. Apply Your Knowledge

a. 4 **b.** 1 **c.** 3 **d.** 2 **e.** 4 **f.** 3 **g.** 1 **h.** 3 **i.** 1 **j.** 1 **k.** 1 **l.** 1 or 4 **m.** 3
n. 1 **o.** 2 **p.** 2 **q.** 3 or 2 **r.** 1

Learn About Living Things

1. In grafting, it is important to remember that the cambium layer of the stem or bud to be grafted must be in contact with the cambium layer of the root or stem onto which it is grafted. A young apple tree with a main trunk about one inch in diameter can be obtained from a nursery early in the spring before it has leafed. The young tree can be set out in rich soil in a lard can, barrel, or a box 3x3x3 feet and cared for in the classroom. Twigs (½ inch in diameter and 18 inches long) from other varieties of apple trees should also be obtained from the nursery. These twigs, or buds from them, can be grafted onto branches of the apple tree by the methods shown on page 368. A sharp knife should be used in cutting twigs and bark. After the graft is made, the twig or bud should be fastened in place with a rubber band. The exposed portion of the graft should be covered with grafting wax. If the graft is successful, leaves will appear on the grafted twig in a few weeks. After the tree has become established, it can be set out in the schoolyard. Furthermore, if apple trees are available in the schoolyard, they can be used for grafting, making it unnecessary to obtain material from a nursery.
2. When examined under a microscope, the yeast cells will resemble the one shown in the upper part of the drawing on page 369, although some yeast cells may not have the bud on them.

3. When viewed through a microscope, the stagnant water will appear to be alive with microscopic plant and animal life. Pupils will be especially interested in watching those that move about.
4. It is recommended that 10cc. of the following antiseptics be used: 2% carbolic acid solution; .1% (1g. per 1000 cc. of water) bichloride of mercury; tincture of iodine; 80% grain alcohol; 10% and 30% salt solutions; and several samples of popularly advertised antiseptics. To make sure that you have some bacteria available for the experiment, grow some in the manner described on page 339. Using bacteria from the same colony or group, inoculate one more petri dish than the number of antiseptics which you intend to test. The extra dish should be kept as a control. After the dishes have been inoculated with bacteria, pour a different antiseptic over each, leaving one without antiseptic. Be sure to label properly each petri dish. Set dishes in a warm place for several days, and make observations to see in which dish bacteria grow. Compare each dish with the control which had no antiseptic in it.
5. Obtain samples of three commercial fertilizers from a local hardware or garden store. Plant the same number of beans in each of eight flowerpots. Add no fertilizer to two of the pots (these are the controls). To each of the other three pairs of pots add one of the fertilizers, being careful not to add too much at any one time. Be sure that equal amounts of each kind of fertilizer are used each time. Control all other conditions such as water, light, and temperature. Keep growth records on each pot for several weeks and compare.
6. Obtain a package of a commercial growth-regulator which advertisements claim will hasten root development on cuttings. Use as directed, and compare results with cuttings that have not been treated with chemicals.
7. Plant grass sod which contains some plants such as dandelions in a box of soil 2 feet x 2 feet x 6 inches. After the sod is growing well, treat it with a commercial weed-killer, being sure to follow carefully the directions given on the container.

Page 436: Test Yourself

1. True **2.** Less **3.** True **4.** More **5.** True

Pages 443–444: Test Yourself

1. c **2.** b **3.** d **4.** c

Page 449: Test Yourself

1. True **2.** 40 per cent **3.** 34 per cent **4.** Lower **5.** True

Page 450: Chapter Activities. Review Your Understanding

1. a,d **2.** a,b,d,e

Reach a Conclusion

4

Page 456: Test Yourself

1. c **2.** b **3.** b **4.** c

Page 463: Test Yourself

1. True. **2.** 10 per cent **3.** Thinned **4.** True **5.** True **6.** True

Page 472: Test Yourself

1. b **2.** c **3.** b **4.** c **5.** a

Pages 472–474: Chapter Activities. Review Your Understanding

1. b,c,e **2.** a,b,d **3.** b,c **4.** b,d,e

Interpret a Graph

1. T **2.** T **3.** S **4.** T **5.** F **6.** T **7.** S **8.** F **9.** T **10.** S

Pages 474–475: Unit Activities. Apply Your Knowledge

1. a,c,e,f **2.** b,c **3.** a,c,d,f **4.** a,b,d,e

Page 483: Test Yourself

1. d **2.** a **3.** c **4.** b **5.** b

Pages 493–494: Test Yourself

1. c **2.** c **3.** b **4.** a **5.** c

Page 494: Chapter Activities. Review Your Understanding

1. a:5 b:2 c:1,2 d:6 e:1 f:2 g:4 h:4 i:3 j:1 k:1 l:1 m:1,5 n:4 o:1

Solve Mathematical Problems

1. 2250 ft.-lbs. **2.** 2475 ft.-lbs. **3.** 90.9% **4.** 1000 lbs. **5.** 20 **6.** 50 lbs.

Pages 502–503: Test Yourself

1. d **2.** c **3.** c **4.** a **5.** d

Pages 511–512: Test Yourself

1. c **2.** b **3.** c **4.** c **5.** b

Pages 512–513: Chapter Activities. Review Power

1. 1:E 2:I 3:I 4:E 5:I 6:I

2. 2,4,3,1

Form a Generalization

1. b,c,d **2.** a,b,c,e,f **3.** a,c,d,f

Pages 513–514 Unit Activities. Apply Your Knowledge

a.1 **b.**2 **c.**2 **d.**4 **e.**3 **f.**3 **g.**2 **h.**1 **i.**1 **j.**1 **k.**3 **l.**3 **m.**2 **n.**4 **o.**4

Page 528: Test Yourself

1. d **2.** b **3.** c **4.** b **5.** b

Page 532: Test Yourself

1. True **2.** Radar **3.** True **4.** Lightship **5.** Tug **6.** Paddle wheels

Page 539: Test Yourself

1. d **2.** d **3.** b **4.** d

Pages 540–541: Chapter Activities. Review Your Understanding

1. b,c,d **2.** a,b,d,e

Page 549: Test Yourself

1. a **2.** c **3.** b **4.** d

Page 554: Test Yourself

1. True **2.** Lower **3.** 55 **4.** Absorbs

Pages 554–555: Chapter Activities. Review Your Understanding

1. 11 **2.** 13 **3.** 9 **4.** 3 **5.** 10 **6.** 2 **7.** 8 **8.** 12 **9.** 7 **10.** 6 **11.** 4 **12.** 1

Use the Facts from a Table

1. a **2.** c

Page 563: Test Yourself

1. a **2.** c **3.** b **4.** b **5.** c

Page 572: Test Yourself

1. a **2.** b **3.** d **4.** b **5.** d

Pages 572–573: Chapter Activities. Solve a Problem

Part 1. 3 **Part 2.** 2,4,7 **Part 3.** 1,4 **Part 4.** 2

Pages 573–574: Unit Activities. Apply Your Knowledge

1. 1 **2.** 5 **3.** 6 **4.** 3 **5.** 2 **6.** 4 **7.** 4

Page 582: Test Yourself

1. True **2.** Strong **3.** True **4.** Control **5.** Radiant energy

Pages 587–588: Test Yourself

1. a **2.** c **3.** d **4.** b **5.** b

Page 588: Chapter Activities. Solve Mathematical Problems

1. 2.7 inches **2.** 27 inches **3.** 30,000 lbs. **4.** 169 lbs. per cu. ft. **5.** 2.86 cm

Review Your Understanding

1.2 **2.**3 **3.**1 **4.**3 **5.**1 **6.**1 **7.**2 **8.**3 **9.**3

Page 594: Test Yourself

1.c **2.**a **3.**d **4.**a **5.**b

Page 599: Test Yourself

1. Cement **2.** True **3.** Sulfide, oxide **4.** True **5.** Magnesium

Page 605: Test Yourself

1. Will not **2.** Lanital **3.** True **4.** Steel **5.** True **6.** Thermoplastic

Pages 605–606: Chapter Activities. Review Your Understanding

1.c **2.**b **3.**a **4.**a **5.**a **6.**c **7.**b **8.**a **9.**c **10.**a **11.**c **12**
13.c **14.**a **15.**a **16.**a **17.**b **18.**b **19.**b **20.**c **21.**a,c **22.**b

Illustrate Generalizations

1. a,c,d.f **2.** a,b,c,d,e **3.** a,b,c,e

Pages 606–607: Unit Activities. Apply Your Knowledge

Part 1. a:3 b:1 c:2 d:3 e:5 f:4 g:1 h:2 i:4 j:5
Part 2. a:2 b:3 c:1 d:4 e:5 f:1 g:2 h:5 i:4

Date Due

RETURN
MAY 4 RETURN
MAR 2 [illegible] RETURN
FEB 23 RETURN
DEC 1 RETURN
FEB 15 1989
MAR 15 RETURN

Q 161 B25 1956 TCH-MAN-
BARNARD JOHN DARRELL 1906-
THE NEW BASIC SCIENCE

40868498 CURR HIST

000027179894